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MILITARY TELEGRAPH STATIONS IN BALLOONS.

Now that the friendly relations between the interior of Egypt and the world have been suspended and diplomatic negotiations are supplemented by the more telling speeches of heavy ordnance, telegraphic communication with the extensive system of Egyptian land lines has naturally ceased. The formerly friendly mission of the telegraph will for the present be used for a more serious object, viz., that of war.

One of the first operations, two opposing armies have to perform, consists in strengthening their own positions and in ascertaining the strength and position of the adversary. This latter object is generally attained by reconnoitering expeditions and by skirmishing and sham attacks, trying either to reach an eminence from whence a better view of the enemy's position may be obtained, or to force the enemy to show his strength.

A less sanguinary and perhaps more efficient mode of ascertaining the enemy's position can be used, viz., captive balloons, connected with the ground by telegraph cables; the aeronaut is thus enabled to communicate his observations to headquarters immediately, not only during a reconnaissance, but also during action. It is to this kind of aerial telegraph station that we wish to draw attention at present.

Balloons were used for reconnoitering purposes as early as the year 1794, during the wars of the French Revolution, and with great success. Two companies of aeronauts were then organised by the French, who used war-balloons at Fleurs, Maubeuge, Charleroi, Mannheim, Ehrenbreitenstein, &c. These balloons were not employed as couriers, but for reconnoitering an enemy, and sometimes the flag-signal telegraph was used. Balloon ascents were also made for the purpose of observing an enemy's movements during a battle, and thus took part in the tactical operations of the engagement.

Colonel Coutelle observed and reported, in June, 1794, from a war-balloon station, the operations of the battle of Fleurs, and the French Academy of Science, convinced of the value of such stations for military reconnoitering, recommended the general introduction of balloons for war purposes. The result was that during the same year a military aeronautical school was created in Meudon under the able direction of the celebrated aeronaut, M. Guyton de Morveau and Colonel Coutelle.

Notwithstanding these attempts, war ballooning little occupied the minds of military men from the beginning of this century until 1859, during the Crimean War, when a balloon was again tried, unfortunately, however, without any valuable results being obtained for the military operations.

To North America is due the honour of having given this half-forgotten companion of modern warfare a practical and new application. We can do no better than quote here from Mr. W. Plum's valuable book "The Military Telegraph," just published in Chicago. Mr. Plum, who was an active and distinguished officer of the American Field Telegraph Corps, says: "War balloons were used in the United States army on the Potomac and during the Peninsular campaign. On all such reconnaissances the balloon was held by ropes, and on several occasions electrical telegraphic connection was kept up with the aeronaut in the sky. This was first accomplished June 17th, 1861, when the War Department, in Washington, was placed in instant communication with Prof. Lowe, who, from his 'high estate,' caused the operator at his side to telegraph to the President of the United States:—

"Sir,—The point of observation commands an area of 50 miles in diameter. The city, with its girdle of encampments, presents a superb scene. I take great pleasure in sending you the first despatch ever telegraphed (electrically) from an aerial station and in acknowledging my indebtedness to your encouragement for the opportunity of demonstrating the availability of the science of aeronautics in the military service of the country.

"Yours respectfully,
"(Signed), T. S. C. LOWE.

"Operator C. T. Brown ascended from Pohick Church, Virginia, with Prof. Wise, and also communicated to the War Department. John La Mountain, another professional aeronaut, made ascents accompanied by General Fitz John Porter . . . . ."

The history of the North American war supplies a series of most valuable facts where balloon telegraph stations took part in the tactical operations of military engagements, and not seldom considerably contributed to the development and final success of the battle. But not only this; the Americans also tried, and with tolerable success, to obtain photographic plans of the enemy's positions taken from their telegraph balloon stations. Thus the country between Richmond, Manchester, and Chikahoming, with its batteries and troops, was photographed.

At the battle of Richmond an outpost telegraph station, placed in a balloon, captive at a height of 300 yards, was in telegraphic communication with headquarters during the whole engagement. General McClellan received immediate information from the balloon of all movements of the enemy, and was thus enabled to issue timely and correct orders to his generals, Heinselmann and Summer, for a simultaneous attack of the enemy from various directions. It is generally acknowledged that the conquest of Richmond and the complete victory of the North army was considerably due to the valuable information received from the balloon outpost telegraph station.

The next balloon reconnaissance was carried out in June, 1867, during the Paraguayan war by Brazil, which country, by the way, claims the invention of the balloon for her countryman Don Guzman, who ascended in a balloon as early as 1736 in presence of John V., the King of Portugal. Mr. von Treuenfeld, who commanded the Paraguayan field telegraph corps, says, in his book on "War Telegraphy," that the Brazilian balloon reconnoitred the fortified positions at Tuyuti and Tuyucué from a height of 200 metres, being fastened to a cable and carried along the enemy's lines by soldiers. The ascents were accompanied by staff officers, who not only drew plans of the hitherto unknown fortifica-

tions, but also counted the 106 guns and three mortars, which a few days later were to be attacked.

During the Franco-German war the French army obtained great assistance through the employment of war-balloons as couriers of military orders, news, &c. Suffice it to say that from September 23rd, 1870, to January 28th, 1871, sixty-two balloons left Paris, fifty-four of which, sent out by the Post-office Department, took 2,500,000 letters, weighing ten tons. Stationary balloons (ballons captifs) were used for reconnoitering purposes, fitted out as Morse telegraph stations, and were connected with the semi-permanent field lines and the headquarters of the commander. The first of these aerial French telegraph stations ascended on November 21st, 1870, at the camp of Gidy, and on December 7th, 1870, a military aeronautical troop was formed and incorporated into the French army, which carried five balloons, to the front of the Loire army. Other balloons operated with the East army at Besançon, and with the North army at Amiens.

It is to be regretted that the information obtained by the French reconnoitering balloon stations during the Franco-German war was not in proportion to the enormous efforts and patriotic devotion of the promoters and troop of the war-balloons. This is by no means an argument against the efficiency of either of them, but only a too natural consequence of want of time for proper organisation. The rapid march of military events during the Franco-German war made the thorough organisation of a balloon service impossible, which, had it been prepared in time of peace, would undoubtedly have been of great service to the French army.

The present intimate connection between French military aeronauts and the Académie d'Aérostation Météorologique sufficiently proves that the French army learned a lesson from their experiences of 1870.

In spite of many recommendations, since 1854, from Mr. Henry Coxwell, the venerable parent of English aeronautics, urging the introduction of balloon signalling stations for reconnoitering purposes into our army equipment, little was tried, and less adopted, for many years. The decision of the War Office was thus hailed with general satisfaction by the army when, in September, 1880, a whole company of the Royal Engineers were detailed for instruction in the art of war-ballooning. Seeing the service entrusted to such distinguished officers as Captain Elsdale, R.E., Lieutenants Nare, Noel, and Anstruther, all of the Royal Engineers, and Captain Templer, of the Royal Edmonton Rifle Militia, strong anticipations existed that the field-telegraph soldier of the C Division of Aldershot Royal Engineers would soon, in an airy balloon station, replace his skirmishing and exposed comrades on *terra firma*. Such anticipations were further strengthened by balloon drills performed by sappers, under the direction of Captain Elsdale and Captain Templer, before General Turner, General Philpott, Admiral Boyes, and other officers, demonstrating the high efficiency of the portable captive balloon with all its newly-invented gear of hydrogen generating apparatus, balloon car, engineers' transport waggon, &c. At a height of about 200 ft. the balloon was drawn about to illustrate the facility with which balloons can be transported to eligible points, and even telegraph lines and railway bridges were crossed with ease by the use of duplicate towing cables. Captain Elsdale, together with Corporal Joliffe and Corporal Thomson, carried on communication from the balloon by means of flag-signalling as well as by the telephone.

Still more promising were these experiments when the Secretary of State for War ordered balloons to be used during the manœuvres at the Brighton review. The ballooning party, consisting of two officers, nine non-commissioned officers and sappers, proceeded to Brighton with two balloons and all necessary equipments. The balloon "Crusader" was inflated and conveyed in safety across a difficult piece of ground to its position, occupied by the outposts of the Lewes force. The distance traversed being about two miles and a half, including the crossing of a tidal river, railway, and telegraph wires. Captain Norton, aide-de-camp, accompanied Captain Elsdale in the balloon, which was sent up about 1,100 ft. These officers were provided with maps of the ground on which it was proposed to make rough sketches of the enemy's positions for the information of the general officer commanding the Lewes forces. Captain Templer succeeded in moving the wagon below, with the balloon attached, at a very rapid pace through the intervals between the advancing battalions. Captain Elsdale reported that when the weather cleared a most excellent view of every man and movement below was obtained. When the troops were dismissed the waggon retired at a gallop, with balloon attached, and returned to Lewes without difficulty. Captain Elsdale thus sums up the valuable experience gained on that occasion: "I would respectfully submit for consideration that the following points would appear to have been established. A balloon, in fairly favourable weather, can be conveyed captive over any ground accessible to infantry to the required position for observation. It can be moved from time to time, as required in the course of the operations, to any other suitable point . . . . . and it seems probable that valuable observations might from time to time be made at all periods of the operations."

Taking all the historical facts together, which naturally are only mentioned here in an exceedingly condensed form, and returning to our subject, military reconnaissances in front of the newly-erected and unknown Egyptian fortifications, we are inclined to think, that a thorough review from a balloon telegraph station, at a height of 300 yards, would not only be a successful mode of reconnoitering, but also a highly interesting repetition of an experiment in scientific strategy, which had so often been successfully carried out at the balloon-drilling grounds and during the Brighton review.

THE BRITISH ASSOCIATION.

The meeting of the present year, which was inaugurated on Wednesday, the 23rd inst., is the fifty-second assemblage of the members of the British Association. Southampton has before had the honour of being the selected centre to which the eminent men of science belonging to this association annually journey. Electrical science should naturally have a greater share of attention than in previous years, for its importance is almost daily becoming more and more apparent. The President of the year, Dr. C. W. Siemens, is one of our leading authorities on this subject, but he does not go far beyond a recapitulation of known facts in his address. He, however, makes several suggestions, and has covered a vast amount of ground. What he says we can accept as correct, for Dr. Siemens is not inclined

to indulge in speculative imagination. Professors Lord Rayleigh, G. D. Liveing, R. Etheridge, and A. Gamgee, preside over the respective sections of Mathematical and Physical Science (A), Chemical Science (B), Geology (C), and Biology (D).

Sections (E), Geography; (F), Economic Science and Statistics; and (G), Mechanical Science, have respectively as Presidents, Sir R. Temple, Bart., Right Hon. G. Sclater-Booth, M.P., and John Fowler, Esq., C.E. The General Treasurer of the Association is Professor A. W. Williamson, of University College, London; and the Secretary is Professor T. G. Bonney.

THE PRESIDENT'S ADDRESS.

In venturing to address the British Association from this chair, I feel that I have taken upon myself a task involving very serious responsibility. The Association has for half a century fulfilled the important mission of drawing together, once every year, scientists from all parts of the country for the purpose of discussing questions of mutual interest, and of cultivating those personal relations which aid so powerfully in harmonising views, and in stimulating concerted action for the advancement of science.

A sad event casts a shadow over our gathering. While still mourning the irreparable loss science had sustained in the person of Charles Darwin, whose bold conceptions, patient labour, and genial mind made him almost a type of unsurpassed excellence, telegraphic news reached Cambridge, just a month ago, to the effect that our honorary secretary, Professor F. M. Balfour, had lost his life during an attempted ascent of the Aiguille Blanche de Peuteret. Although only thirty years of age, few men have won distinction so rapidly and so deservedly. After attending the lectures of Michael Foster, he completed his studies of Biology under Dr. Anton Dohrn at the Zoological Station of Naples in 1875. In 1878 he was elected a Fellow, and in November last a member of Council of the Royal Society, when he was also awarded one of the royal medals for his embryological researches. Within a short interval of time Glasgow University conferred on him their honorary degree of LL.D., he was elected President of the Cambridge Philosophical Society, and after having declined very tempting offers from the Universities of Oxford and Edinburgh, he accepted a professorship of Animal Morphology created for him by his own university. Few men could have borne without hurt such a stream of honourable distinctions; but in young Balfour genius and independence of thought were happily blended with industry and personal modesty; these won for him the friendship, esteem, and admiration of all who knew him.

Since the days of the first meeting of the Association in York in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special societies which have sprung into existence since the foundation of the British Association, amongst which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnean, cultivating abstract science, and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and of Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical Industry, representing applied science. These meet at frequent intervals in London, whilst others, having similar objects in view, hold their meetings at the University towns, and at other centres of intelligence and industry throughout the country, giving evidence of great mental activity, and producing some of those very results which the founders of the British Association wished to see realised. If we consider further the extraordinary development of scientific journalism which has taken place, it cannot surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's anniversary meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affections of its members, and it behoves us at this, the first ordinary gathering in the second half century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness.

If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific inquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, whilst the simple practitioner was at a loss how to harmonise the new knowledge with the stock of information which formed his mental capital in trade.

The advancement of the last fifty years has, I venture to submit, rendered theory and practice so inter-dependent that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new colouring matters derived from waste products, such as coal-tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon, electrical science as established by purely theoretical research in the laboratory. In general engineering the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect, would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, moreover, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature, who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule of thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye when he defined civil engineering as "the art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science—under whose ample shadow its cultivators will find it both profitable and pleasant to meet, at least once a year; and considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are without exception of general interest, but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations, the formation of a universal code for signalling at sea, and for distinguishing lighthouses, and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France towards the close of last century; but, considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalised in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the metre consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard metre is kept in the Standards' Department of the Board of Trade, it is impossible to procure legalised rods representing it, and to use a non-legalised copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavour to bring about the use in this country of the metre and kilogramme, and as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sèvres possesses, independently of its practical work, considerable scientific interest as a well-found laboratory for developing methods of precise measurement?

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity.

The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantites and effects with almost mathematical precision; and although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapt in mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers), are amongst the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur, to exercise their direct and important influence.

If, then, electricity stands foremost amongst the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago, very little advance had been made towards the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance and quantity of current; Joule had established the dynamical equivalent of heat and electricity, and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson,

and it is to the long-continued activity of this Committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris.

At this Congress, which was attended officially by the leading physicists of all civilised countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The Congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several Governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labour is utilised; only, instead of expressing electrical quantities directly in absolute measure, the Congress has embodied a consistent system, based on the ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the Ohm, Ampère, Volt, Coulomb, and Farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "Weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the Congress in order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an Ampère through the difference of potential of a Volt is the unit consistent with the practical system. It might be appropriately called a Watt, in honour of that master mind in mechanical science James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A Watt, then, expresses the rate of an Ampère multiplied by a Volt, whilst a horse-power is 746 Watts, and a Cheval de Vapeur 735.

The system of electro-magnetic units would then be:—

(1)	Weber, the unit of	magnetic	quantity	$= 10^8$ C.G.S. Units.
(2)	Ohm	,,	resistance	$= 10^9$,,
(3)	Volt	,,	electromotive force	$= 10^8$,,
(4)	Ampère	,,	current	$= 10^{-1}$,,
(5)	Coulomb	,,	quantity	$= 10^{-1}$,,
(6)	Watt	,,	power	$= 10^7$,,
(7)	Farad	,,	capacity	$= 10^{-9}$,,

Before the list can be looked upon as complete two other units may have to be added, the one expressing that of magnetic field, and the other of heat in terms of the electromagnetic system. Sir William Thomson suggested the former at the Paris Congress, and pointed out that it would be proper to attach to it the name of Gauss, who first theoretically and practically reduced observations of terrestrial magnetism to absolute measure. A Gauss will, then, be defined as the intensity of field produced by a Weber at a distance of one centimetre; and the Weber will be the absolute C.G.S. unit strength of magnetic pole. Thus the mutual force between two ideal point-poles, each of one Weber strength held at unit distance asunder, will be one dyne; that is to say, the force which acting for a second of time on a gramme of matter, generates a velocity of one centimetre per second.

The unit of heat has hitherto been taken variously as the heat required to raise a pound of water at the freezing-point through 1° Fahrenheit or Centigrade, or, again, the heat necessary to raise a kilogramme of water 1° Centigrade. The inconvenience of a unit so entirely arbitrary is sufficiently apparent to justify the introduction of one based on the electromagnetic system, viz., the heat generated in one second by the current of an Ampère flowing through the resistance of an Ohm. In absolute measure its value is 10^7 C.G.S. units, and assuming Joule's equivalent as 42,000,000, it is the heat necessary to raise 0·238 grammes of water 1° Centigrade, or, approximately, the 1-1000th part of the arbitrary unit of a pound of water raised 1° Fahrenheit and the 1-4000th of the kilogramme of water raised 1° Centigrade. Such a heat unit, if found acceptable, might with great propriety, I think, be called the Joule, after the man who has done so much to develop the dynamical theory of heat.

Professor Clausius urges the advantages of the statical system of measurement for simplicity, and shows that the numerical values of the two systems can readily be compared by the introduction of a factor, which he proposes to call the critical velocity; this, Weber has already shown to be nearly the same as the velocity of light. It is not immediately evident how by the introduction of a simple multiple, signifying a velocity, the statical can be changed into dynamical values, and I am indebted to my friend Sir William Thomson for an illustration which struck me as remarkably happy and convincing. Imagine a ball of conducting matter so constituted that it can at pleasure be caused to shrink. Now let it first be electrified and left insulated with any quantity of electricity on it. After that, let it be connected with the earth by an excessively fine wire, or a not perfectly dry silk fibre; and let it shrink just so rapidly as to keep its potential constant, till the whole charge is carried off. The velocity with which its surface approaches its centre is the electrostatic measure of the conducting power of the fibre. Thus we see how "conducting power" is, in electrostatic theory, properly measured in terms of a velocity. Weber had shown how, in electromagnetic theory, the resistance, or the reciprocal of the conducting power of a conductor, is properly measured by a velocity. The critical velocity, which measures the conducting power in electrostatic reckoning and the resistance in electromagnetic, of one and the same conductor, measures the number of electrostatic units in the electromagnetic unit of electric quantity.

Without waiting for the assembling of the International Committee charged with the final determination of the Ohm, one of its most distinguished members, Lord Rayleigh, has, with his collaborateure, Mrs. Sidgwick, continued his important investigation in this direction at the Cavendish Laboratory, and has lately placed before the Royal Society a result which will probably not be surpassed in accuracy. His redetermination brings him into close accord with Dr. Werner Siemens, their two values of the mercury unit being 0·95418 and 0·9536 of the B.A. unit respectively, or 1 mercury unit $= 0{\cdot}9413 \times 10^9$ C.G.S. units.

Shortly after the publication of Lord Rayleigh's recent results, Messrs. Glazebrook, Dodds, and Sargant, of Cambridge communicated to the Royal Society two determinations of the Ohm, by different methods; and it is satisfactory to find that their final values differ only in the fourth decimal, the figures being, according to

Lord Rayleigh .. .. 1 Ohm $= 0{\cdot}98651 \frac{\text{Earth Quadrant}}{\text{Second}}$

Messrs. Glazebrook, &c. .. $= 0{\cdot}986439$,,

Professor E. Wiedemann, of Leipzig, has lately called attention to the importance of having the Ohm determined in the most accurate manner possible, and enumerates four distinct methods, all of which should unquestionably be tried with a view of obtaining concordant results, because upon its accuracy will depend the whole future system of measurement of energy of whatever form.

The word Energy was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labours of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other labourers, who have accomplished for the science regarding the forces in Nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards chemistry. In this short word Energy we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many 'modes of motion.' It will readily be conceived that when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realising it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss, but, considering that energy is indestructible, represents really secondary effect, which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit, when the heat rays become visible, and we have the incandescence electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism, but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching probably under favourable conditions that of radiant heat and light, or 300,000 kilometres per second; it refuses, however, to pass through oxidised substances, glass, gums, or through gases, except when in a highly rarefied condition. It is easy therefore to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel; it consists of a copper wire, or strand of wires, 5 mm. in diameter, by nearly 5,000 kilometres in length, confined electrically by a coating of gutta-percha about 4 mm. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the 4 mm. in thickness of insulating material. By an improved arrangement the alternating currents employed to work long submarine cables do not actually complete the circuit, but are merged in a condenser at the receiving station, after having produced their extremely slight but certain effect upon the receiving instrument. So perfect is the channel and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at either end. By the application of this duplex mode of working to the Direct United States cable, under the superintendence of Dr. Muirhead, its transmitting power was increased from 25 to 60 words a minute, being equivalent to about twelve currents or primary impulses per second. In transmitting these impulse-currents simultaneously from both ends of the line, it must not be imagined, however, that they pass each other in the manner of liquid waves belonging to separate systems; such a supposition would involve momentum in the electric flow, and although the effect produced is analogous to such an action, it rests upon totally different grounds—namely, that of a local circuit at

each terminus being called into action automatically whenever two similar currents are passed into the line simultaneously from both ends. In extending this principle of action quadruplex telegraphy has been rendered possible, although not yet for long submarine lines.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice, naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor current in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent according to its strength. Savart found that the fundamental *la* springs from 440 complete vibrations in a second, but what must be the frequency and modulations of the motor current and of magnetic variations necessary to convey to the ear through the medium of a vibrating armature such a complex of human voices and of musical instruments as constitutes an opera performance? And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the footlights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct the microphone, the names of Reis, Graham Bell, Edison, and Hughes will ever be remembered.

Considering the extreme delicacy of the currents working a telephone, it is obvious that those caused by induction from neighbouring telegraphic line wires would seriously interfere with the former and mar the speech or other sounds produced through their action. To avoid such interference the telephone wires if suspended in the air require to be placed at some distance from telegraphic line wires, and to be supported by separate posts. Another way of neutralising inteference consists in twisting two separately insulated telephone wires together, so as to form a strand, and in using the two conductors as a metallic circuit to the exclusion of the earth; the working current will, in that case, receive equal and opposite inductive influences, and will therefore remain unaffected by them. On the other hand two insulated wires instead of one are required for working one set of instruments; and a serious increase in the cost of installation is thus caused. To avoid this Mr. Jacob has lately suggested a plan of combining pairs of such metallic circuits again into separate working pairs, and these again with other working pairs, whereby the total number of telephones capable of being worked without interference is made to equal the total number of single wires employed. The working of telephones and telegraphs in metallic circuit has the further advantage that mutual volta induction between the outgoing and returning currents favours the transit, and neutralises on the other hand the retarding influence caused by charge in underground or submarine conductors. These conditions are particularly favourable to underground line wires, which possess other important advantages over the still prevailing overground system, in that they are unaffected by atmospheric electricity, or by snowstorm and heavy gales, which at not very rare intervals of time put us back to pretelegraphic days, when the letter-carrier was our swiftest messenger.

The underground system of telegraphs, first introduced into Germany by Werner Siemens in the years 1847-8, had to yield for a time to the overground system owing to technical difficulties, but it has been again resorted to within the last four years, and multiple land cables of solid construction now connect all the important towns of that country. The first cost of such a system is no doubt considerable (being about £38 per kilometre of conductor as against £8 10s. the cost of land lines); but as the underground wires are exempt from frequent repairs and renewals, and as they insure continuity of service, they are decidedly the cheaper and better in the end. The experience afforded by the early induction of the underground system in Germany was not, however, without its beneficial results, as it brought to light the phenomena of lateral induction, and of faults in the insulating coating, matters which had to be understood before submarine telegraphy could be attempted with any reasonable prospect of success.

Regarding the transmission of power to a distance the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope as used at Schaffhausen to utilise the power of the Rhine fall. The transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed ten per cent., as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in reconverting the current into mechanical effect, a total loss of 19 per cent. results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of $100 - 38 = 62$ per cent., attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent. of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power the loss cannot be taken at less than 50 per cent., and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases as 50 per cent., electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarisation; but as this second conductor need not be insulated, water or gas pipes, railway metals or fencing wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive power with a consumption of two pounds of coal per horse-power per hour, whereas small engines distributed over a district would consume not less than five; we thus see that there is an advantage in favour of electric transmission as regards fuel, independently of the saving of labour and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and fields from one centre. Having worked such a system myself in combination with electric lighting and horticulture for upwards of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation, there is little to add to what was stated in my paper read before Section A last year, and ordered to be printed with the report, except that in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there was a marked difference between the growth of the plants influenced and those uninfluenced by the electric light. This was not very apparent till towards the end of February, when, with the first appearance of mild weather, the plants under the influence of an electric lamp of 4,000 candle-power placed about 5 metres above the surface, devolved with extreme rapidity, so that by the end of May they stood above four feet high, with the ears in full bloom, when those not under its influence were under two feet in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. At the Paris Electrical Exhibition the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which when completed will have a length of twelve miles), a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running downhill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam-power for towns, in tunnels, and in all cases where natural sources of energy, such as waterfalls, are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways. The transmission of power by means of electric conductors possesses the further advantage over other means of transmission that, provided the resistance of the rails be not very great, the power communicated to the locomotive reaches its maximum when the motion is at its minimum—that is, in commencing to work, or when encountering an exceptional resistance—whereas the utmost economy is produced in the normal condition of working when the velocity of the power-absorbing nearly equals that of the current-producing machine.

The deposition of metals from their solutions is perhaps the oldest of all useful applications of the electric current, but is only in very recent times that the dynamo current has been practically applied to the refining of copper and other metals, as now practised at Birmingham and elsewhere, and upon an exceptionally large scale at Ocker, in Germany. The dynamo machine there employed was exhibited at the Paris Electrical Exhibition, its peculiar feature being that the conductors upon the rotating armature consisted of solid bars of copper, 30 mm. square, in section, which were found only just sufficient to transmit the large quantity of electricity of low ten on necessary for this operation. One such machine consuming 4 horse-power deposits about 300 kilogrammes of copper per 24 hours, the motive power at Ocker is derived from a waterfall.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and St. Claire De Ville have taught us, however, that combustion becomes extremely sluggish when a temperature of 1,800° C. has been reached, and for effects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and metallurgist. Tungsten has been melted in such a furnace, and 8 pounds of platinum have been reduced from the cold to the liquid condition in 20 minutes.

The largest and most extensive application of electric energy at the present time is to lighting, but considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that if an electric current is passed through a conductor the whole of the energy lost by the current is converted into heat; or, if the resistance be localised, into radiant energy comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light.

Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most

valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1,700° C., formed 1-24th part of the total radiant energy emitted, and 1-10th part in the case of an arc light worked by a battery of 50 Grove's elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electromotive force of 98·5 Volts, and an internal resistance of 13·5 Ohms, giving a current of 7·3 Ampères when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 ohms, the current produced in the arc would be $\frac{98{\cdot}5}{13{\cdot}5+10+1} = 4$ Ampères (allowing one Ohm for the leads), and the power consumed $10 \times 4^2 = 160$ Watts; the light power of such an arc would be about 150 candles, and comparing this with an arc of 3,308 candles produced by 1,162 Watts, we find that $\left(\frac{1,162}{160}\right)$, *i.e.*, 7·3 times the electric energy produce $\left(\frac{3,308}{150}\right)$, *i.e.*, twenty-two times the amount of light measured horizontally. If, therefore, in Dr. Tyndall's arc 1-10th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3,300 candles, $\frac{1}{10} \times \frac{22{\cdot}0}{7{\cdot}3}$ or fully $\frac{1}{3}$, are luminous rays. In the case of the incandescence light (say a Swan light of 20 candle-power) we find in practice that nine times as much power has to be expended as in the case of the arc light; hence, $\frac{1}{3} \times \frac{1}{9} = 1\text{-}27$ part of the power is given out as luminous rays, as against 1-24th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinimetric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly over-estimated.

The principal argument in favour of the electric light is furnished by its immunity from products of combustion which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that even though its cost should be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theatres and concert-rooms, museums, churches, warehouses, show-rooms, printing establishments, and factories, and also the cabins and engine-rooms of passenger steamers. In the cheaper and more powerful form of the arc light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbours, railway stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operations both by sea and land.

The electric light may be worked by natural sources of power such as waterfalls, the tidal wave, or the wind, and it is conceivable that these may be utilised at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power supply, while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognised by the British Government, who have just passed a Bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas-lighting will hold its own as the poor man's friend.

Dr. Siemens next dealt with the question of gas, giving it as his opinion that the time was not far distant when we should all resort to gas as a heating agent on the grounds of convenience, cleanliness, and economy. He said that the quasi-monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. They seemingly gave merely the prescribed illuminating power, discouraged the invention of economical burners, and the application of gas for heating purposes was partially discountenanced. The introduction of the electric light had, however, convinced gas managers that such a policy is no longer tenable.

The President then spoke of the coal-tar industry and the discovery of the aniline dyes, and he also alluded to the importance of ammonia as a manure, for the supply of which we have to look almost exclusively to our gas-works. In speaking of the use—or rather abuse—of using raw coal for heating purposes, he stated that Professor Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to 50 tons, and that the poisonous carbonic oxide may be taken as at least five times that amount. Mr. Aitken had shown that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog. In commenting upon the luminosity of gas, the lecturer went on to say :—

The amount of light given out by a gas flame depends upon the temperature to which the particles of solid carbon in the flame are raised, and Dr. Tyndall has shown that of the radiant energy set up in such a flame only the 1-25th part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air currents or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2,300° C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gas-lighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versa*, by means of the dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able by this method to determine the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable.

In the condensing steam engine this waste heat comprises that communicated to the condensing water, whilst the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C. except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell. To obtain more advantageous primary conditions we have to turn to the caloric or gas engine, because in them the co-efficient of efficiency expressed by $\frac{T-T'}{T}$ may be greatly increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T′ reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas engine worked by a combustible mixture of air and hydrocarbons than in the steam engine.

Assuming, then, in an explosive gas engine a temperature of 1,500° C. at a pressure of 4 atmospheres, we should, in accordance with the second law of thermo-dynamics, find a temperature after expansion to atmospheric pressure of 600° C., and therefore a working range of $1500° - 600° = 900°$, and a theoretical efficiency of $\frac{900}{1500+274}$ = about one-half, contrasting very favourably with that of a good expansive condensing steam engine, in which the range is $150 - 30 = 120°$ C., and the efficiency $\frac{120}{150+274} = \frac{2}{7}$. A good expansive steam engine is therefore capable of yielding as mechanical work 2-7th part of the heat communicated to the boiler, which does not include the heat lost by imperfect combustion, and that carried away in the

chimney. Adding to these the losses by friction and radiation in the engine, we find that the best steam engine yet constructed does not yield in mechanical effect more than 1-7th part of the heat energy residing in the fuel consumed. In the gas engine we have also to make reductions from the theoretical efficiency, on account of the rather serious loss of heat by absorption into the working cylinder, which has to be cooled artificially in order to keep its temperature down to a point at which lubrication is possible; this together with frictional loss cannot be taken at less than one-half, and reduces the factor of efficiency of the engine to 1-4th.

It follows from these considerations that the gas or caloric engine combines the conditions most favourable to the attainment of maximum results, and it may be reasonably supposed that the difficulties still in the way of their application on a large scale will gradually be removed. Before many years have elapsed we shall find in our factories and on board our ships engines with a fuel consumption not exceeding 1 pound of coal per effective horse-power per hour, in which the gas producer takes the place of the somewhat complex and dangerous steam boiler. The advent of such an engine and of the dynamo-machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the early part of our century.

Dr. Siemens then considered the probable effect of such an engine upon our merchant navy, and gave interesting statistics from "Lloyd's Register of Shipping." He also touched upon the hydrographic department of the navy, and the subject of tidal action :—

The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass, due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighbourhood of the binnacle, but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876 Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principles to be applied completely. With this compass correctors can be arranged so that the needle shall point accurately in all directions, and these correctors can be adjusted at sea from time to time, so as to eliminate any error which may arise through change in the ship's magnetism or in the magnetism induced by the earth through change of the ship's position. By giving the compass card a long period of free oscillation, great steadiness is obtained when the ship is rolling.

Sir William Thomson has also enriched the art of navigation by the invention of two sounding machines; the one being devised for ascertaining great depths very accurately in less than one quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel pianoforte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained not by the quantity of wire run over its counter and brake wheel, but through the indications produced upon a simple pressure gauge, consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver, rendered colourless by the sea-water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls "soundings" can hardly be exaggerated; with the sounding machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations and of the sight of lighthouses or the shore. By the proper use of this apparatus, such accidents as happened to the mail steamer *Mosel* not a fortnight ago would not be possible. As regards the value of the deep-sea instrument, I can speak from personal experience, as on one occasion it enabled those in charge of the cable s.s. *Faraday* to find the end of an Atlantic cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings in the supposed neighbourhood of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable, twenty miles away from the point where dead reckoning had placed the ruptured end.

Whether or not it will ever be practicable to determine oceanic depths without a sounding line, by means of an instrument based upon gravimetric differences, remains to be seen. Hitherto the indications obtained by such an instrument have been encouraging, but its delicacy has been such as to unfit it for ordinary use on board a ship when rolling.

Here the lecturer dwelt upon the great engineering works of the present day, beginning with the Panama Canal, the gigantic undertaking recently commenced by M. de Lesseps. He also mentioned jointly with this project the ship railway of Captain Eads, which is intended to take the largest vessels, from sea to sea, over a railway across the Isthmus of Tehuantepec, a distance of ninety-five miles. A third enterprise with which the name of M. de Lesseps is connected was touched upon, that of flooding the Tunis-Algerian Chotts.

Dr. Siemens then dealt consecutively with the new Eddystone Lighthouse, the St. Gothard Tunnel, the English Channel Tunnel, the undermining of the estuaries of the Severn and Mersey for the purpose of connecting the railway systems on the two sides, and the spanning of the Frith of Forth by a bridge exceeding in grandeur anything as yet attempted by the engineer. He concluded this portion of his discourse by his remarks on the researches of Prof. Abel and Captain Noble on the action of explosives.

The extraordinary difference of condition before and after its ignition, of such matter as constitutes an explosive agent leads us up to a consideration of the aggregate state of matter under other circumstances. As early as 1776, Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelberg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously as in flint glass, or only slowly as in crown glass, and that the elastic limit of both is diminished by electrification, whereas in the case of mica and of gutta-percha an increase of elasticity takes place.

Still greater strides are being made at the present time towards a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exhaustion to limits which had formerly been scarcely reached by the imagination. At each step the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force. The radiometer of Crookes imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum tubes was Ruhmkorff's coil; but Mr. Gassiot first succeeded in obtaining the phenomena by means of a galvanic battery of 3,000 Leclanché cells. Dr. De La Rue, in conjunction with his friend Dr. Hugo Müller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture "On the Phenomena of Electric Discharge," delivered at the Royal Institution in January, 1881, he applied a battery of his invention consisting of 14,400 cells (14,832 Volts), which gave a current of 0·054 Ampère, and produced a discharge at a distance of 0·71 inch between the terminals. During last year he increased the number of cells to 15,000 (15,450 Volts), and increased the current to 0·4 Ampère, or eight times that of the battery he used at the Royal Institution.

With the enormous potential and perfectly steady current at his disposal, Mr. De La Rue has been able to contribute many interesting facts to the science of electricity. He has shown, for example, that the beautiful phenomena of the stratified discharge in exhausted tubes are but a modification and a magnification of those of the electric arc at ordinary atmospheric pressure. Photography was used in his experiments to record the appearance of the discharge, so as to give a degree of precision otherwise unattainable in the comparison of the phenomena. He has shown that between two points the length of the spark, provided the insulation of the battery is efficacious, is as the square of the number of cells employed. Mr. De La Rue's experiments have proved that at all pressures the discharge in gases is not a current in the ordinary acceptation of the term, but is of the nature of a disruptive discharge. Even in an apparently perfectly steady discharge in a vacuum tube, when the strata as seen in a rapidly-revolving mirror are immovable, he has shown that the discharge is a pulsating one; but, of course, the period must be of a very high order.

At the Royal Institution, on the occasion of his lecture, Mr. De La Rue produced, in a very large vacuum tube, an imitation of the Aurora Borealis; and he has deduced from his experiments that the greatest brilliancy of Aurora displays must be in an altitude of from thirty-seven to thirty-eight miles—a conclusion of the highest interest, and in opposition to the extravagant estimate of 281 miles at which it had been previously put.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says: "It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:—

"1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge; that a striated column is an aggregate of such units formed by means of a step-by-step process, and that the negative glow is merely a localised stria, modified by local circumstances.

"2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand

for negative electricity, and that the dark spaces are those regions where the negative terminal, whether metallic or gaseous, is capable of exerting sufficient influence to prevent such demand.

"3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crookes' radiations) in traversing the tubes. Also that, especially in high vacua, the discharge from the negative terminal exhibits a durational character not found at the positive.

"4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge; and that for action so rapid as that of individual discharges, the mobility of the medium may count as nothing; and that for these infinitesimal periods of time gas may itself be as rigid and as brittle as glass.

"5. That striæ are not merely loci in which electrical is converted into luminous energy, but are actual aggregations of matter.

"This last conclusion was based mainly upon experiments made with an induction coil excited in a new way, viz., directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplification which it permits in the construction of induction coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise."

These investigations assume additional importance when we view them in connection with solar—I may even say steller—physics, for evidence is augmenting in favour of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectroscope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far distant nebulæ, which have yielded spectroscopic photographs under the skilful management of Dr. Huggins, and Dr. Draper of New York. Armed with greatly improved apparatus the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses; that of 1879, visible in America, and that of May last, observed in Egypt by Lockyer, Schuster, and by Continental observers of high standing. The result of this last eclipse exhibition has been summed up as follows: "Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydrocarbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz.:—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That the effect of solar rotation is to draw in dissociated vapours upon the polar surfaces, and to eject them after combustion has taken place back into space equatorially.

It is therefore a matter of peculiar gratification to me that the results of observation here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper) were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Prof. Langley, of Pittsburg, has shown by means of his Bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Captain Abney has found by his new photometric method that absorption due to hydro-carbons takes place somewhere between the solar and terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffel with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydro-carbon and aqueous vapour would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognise principles of high perfection, applicable also to comparatively humble purposes of human life.

We shall thus find that in the great workshop of nature there are no lines of demarcation to be drawn between the most exalted speculation and commonplace practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through His works. So then, we members of the British Association, and fellow-workers in every branch of science, may exhort one another in the words of the American bard who has so lately departed from amongst us:—

Let us then be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labour and to wait.

CALLENDER'S INSULATING MATERIAL.

SOME two months since we paid a visit to the Bitumen Works of Callender's Company, for the purpose of inspecting the manufacture of a new insulating compound prepared from crude bitumen. We were then favourably impressed with its adaptability for the above purpose. Upon the invitation of the Messrs. Callender we have had an opportunity during the last week of making a series of tests on several sections of vulcanised bitumen core, amounting altogether to some four miles.

The electromotive force of the battery we employed for this purpose was 300 volts, and ten minutes' readings were taken with each current on the lengths submitted to us. The size of the core was No. 18 copper, covered to No. 7 B. W. G.

As we shall shortly have occasion to take further tests, we do not purpose publishing the figures we obtained at present, and shall therefore content ourselves with stating that the results were highly satisfactory, and that the good opinion we had already entertained of this substitute for gutta-percha and india-rubber was more than upheld.

Mr. Callender's invention consists in the use of bitumen, combined with other hydro-carbons, or their equivalents, so as to produce a compound material. The natural deposit of bitumen is obtained from Trinidad, and is refined in the usual way. It is combined with oil residue, obtained by subjecting vegetable or other oils to distillation for such a time and in such a manner as to leave the residues in an elastic condition. In some cases Mr. Callender employs with these materials ozokerit, paraffin, or other wax, but this is not always essential.

The compound is then vulcanised, and it is then found to be an efficient substitute for either india-rubber or gutta-percha. The ingredients used are, of course, comparatively inexpensive, and the result is that the compound material can be manufactured and applied at a price considerably less than either of the former insulators. This method of covering wires being of quite recent date, we cannot give any particulars as to the lasting capabilities of the material, but being a mineral substance, and not vegetable, it would appear that it should be practically imperishable. We have no object in recommending Mr. Callender's system other than in the interests of electrical industries, and we have therefore no hesitation in saying that we believe Mr. Callender's invention is the beginning of great advances in cheapening our present insulated conductors. We shall note carefully the results of the tests of this material from time to time, as improved manufacture brings out more prominently the advantages promised by the use of the compound. At the present moment we can safely say that the subject on which we have made these remarks is one eminently worthy of the consideration of electricians; for whatever class of work they may be engaged in, they must all feel the want of reliable means of insulating wires otherwise than by the use of the two best known and most expensive materials.

THE EDISON ELECTRIC LIGHT AT THE GENERAL POST-OFFICE.

THE Edison Electric Light Company has completed an important installation at the General Post-office.

The officials at the Post-office have for some time been desirous of lighting the operating rooms in some satisfactory manner by the electric light. In the Press room, at the top of the buildings in St. Martin's-le-Grand, there are engaged some 1,200 operators. A considerable portion of these are engaged on night duty, and it is important that this room should be well illuminated. Apart from the vitiation of the air by gas, it is obvious that the health of the operatives and their capability for work, would be increased by some system of illumination which should light without unnecessarily heating the apartment. Various 'systems" of electric light have been tried. One insuperable objection to most of these, apart from failures and accidents,

has been that the space of the Post-office is far too valuable to spare for dynamos and engines and boilers. Hence the problem remained unsolved.

It has now however received its solution at the hands of the Edison Electric Light Company. As is well known, the fundamental principle of the Edison system is the supply of electricity from a central station. For five months, without intermission, the Holborn Viaduct has been so supplied from the station at No. 57, Holborn Viaduct.

The shops, streets, hotels, and church, have received without fail the current necessary to supply them with light. On being applied to by the Post-office authorities to extend this supply system, the Edison Company complied with the request by laying down a cable along Newgate Street. The distance from the dynamo-room to the Press department in the Post-office is 1,950 ft. A cable composed of eight No. 10 wires was laid down in a creosoted teak trough under the pavement. Starting from the extremity of the electric mains previously laid down on the Viaduct subway, the cable extends for 1,014 ft. to the entrances to the Post-office. It was important to secure a sufficient insulation. This was achieved by overlaying the cable with insulated tape, and then laying it in grooves in the trough on bearers of insulite, placed one foot apart. The trough was then sealed up with the usual insulation compound. At intervals five testing stations were established. The total copper resistance of the double length of cable is 0·024 ohms. On entering the building the cable runs up the wall in an iron pipe, and enters the operating room. One of the Edison electric meters registers the amount of electricity which passes in. In the operating room, 63 of the 16-candle Edison incandescent lights are placed. These are, at present, attached to the gas fixtures. Over each electric lamp is a porcelain shade to throw down the light on the operator's work. At each branch wire leading to the lamp is one of the "safety catch protectors," consisting of a lead wire of such gauge as to carry the normal amount of current for each lamp, but to fuse with any excess. The evil effects of an accidental cross in the wires are thus prevented.

The whole of this work has been carried out by the company's staff in about ten days.

On Monday night the lamps were lighted for the first time in the presence of the officials of the Post-office. On turning off the gas and switching on the current, the room was silently illuminated with a uniform light, steady, soft, and considerably exceeding in brilliancy the gas which it replaced. The contrast between the calm, cool illumination of that portion of the gallery lighted by the incandescent light and that portion which still suffered under gas illumination was very marked.

No one who witnessed the experiment of last Monday night could fail to be struck with the absurdity of the remark still occasionally heard that electric lighting is still in an "experimental stage." In this case we have more than sixty lights, giving a uniformly steady light, absolutely under control by switches on each lamp and on each circuit supplied on a meter from a station nearly one-third of a mile away. A few lights are also to be placed in another room in the building. Nothing could better have demonstrated than this installation the exact adaptability of the Edison incandescent light for night work requiring good illumination.

A Sine-Rheonome.—By E. v. Fleischl.—A wooden ball of 4·5 centimetres diameter, covered with coils of thick wire, revolves within a hollow wooden ball of 6 centimetres in diameter, composed of two halves, and covered with many coils of fine wire (2 kilometres in length). By means of suitable connections a current is passed through the coil of the internal ball. In the coils of the outer ball, which are parallel to those of the inner, a current is induced by the rotation of the inner on an axle parallel to the plane of the coils. The induced electromotive force varies as the sine of an equally increasing arc.—*Wiedemann's Beiblätter.*

APPLICATIONS OF ELECTRICITY TO THE TRANSMISSION OF FORCE IN THE FRENCH MINES.

The transmission of force to a distance by means of electricity has been confined almost entirely up to the present to the domain of pure speculation or of laboratory experiments. While noting these researches, made by professional electricians, it is not uninteresting to describe the experiments of a more practical nature made by the engineers in certain French mines. We shall find in them very careful observations and information all the more useful because it is not based on fixed ideas or interested considerations, having for their object to show the superiority of a certain system over all others.

The most important application to which we wish to call the attention of our readers is that made at the mines of La Perronière by MM. Charousset and Bague. The results obtained were communicated by the experimentalists to the *Société de l'Industrie Minérale* at the last Congress held at Alais in December, 1881; the report of MM. Charousset and Bague was published in full in the bulletin of the society. We shall select from it the essential parts, leaving out certain definitions too elementary for our readers, and certain other parts which relate more to the working of mines than to electricity.

The transmission of force at the mines of La Perronière has for its object to dispense with the extraction by means of horses which, with the mode of working necessitated by the conditions of the mine, would have been too hard work. These conditions necessitated the placing of an inclined descent on the line of the greatest slope of the grant, and a windlass placed at the head of the descent.

The distance between the motor and the windlass, which is itself placed 555 metres below the soil, is 1,200 metres, made up as follows:—

	Metres.
From the motor to the head of the oaken shaft ..	25
The length of the shaft	390
A gallery almost straight	380
A false shaft	30
A rounded gallery	290
A false shaft	25
A gallery	60
Total length	1,200

This long distance rendered the employment of steam impossible; the necessity of laying down and maintaining 1,200 metres of tubes of compressed air, through winding galleries and shafts, also excluded that agent; therefore recourse was had to electricity.

The complete installation comprises a horizontal steam engine, placed near the drawing-shaft, and working two Gramme machines (generators), which send the current to two similar machines (motors), which work a windlass placed at the head of the descent. This descent, which serves to draw up the coal-tubs, is really 110 metres long, following the slope, and has an inclination of 40 centimetres per metre.

Generating Machines.—The motor which works the generating machines has a single cylinder and variable expansion, on the Meyer system, and is furnished with a Buss governor. It makes 65 revolutions per minute. The fly-wheel of the engine works an intermediate shaft, making 195 revolutions, which in its turn actuates a second intermediate shaft, performing 325 revolutions. This second shaft bears pulleys, which act directly upon the Gramme machine by friction; and for this purpose the extremities of the axles of the machines are furnished with rollers of compressed paper, and turning at 1,300 revolutions.

The type of Gramme machine employed in the mines of La Perronière is that called *octagonal*, with four poles and four collecting brushes; the corresponding poles are placed opposite to each other, and the ring changes in polarity four times in each revolution.

Receiving machines and windlass.—The receiving machines disposed inside the mine, bear, like those outside, two friction rollers of compressed paper. They are placed symmetrically in relation to the transmitters, and oscillate round a horizontal axle which serves them as a support. This frictional motion is utilised for the starting and the stopping of the windlass. The oscillation of the

Gramme machines in one direction brings the friction rollers into contact with the pulleys which are connected with the windlass by means of straps, and effect the starting. The oscillation in the contrary direction draws back the friction rollers and stops the windlass.

The slackening of speed at the commencement is effected by allowing the rollers to rub against the pulleys. In order that these operations may be performed regularly, independently of the degree of skill of the workman, the regulation of the oscillation of the machines is effected by means of a system of jointed levers and a screw worked by a fly-wheel. The degree of contact which must not be exceeded is determined by a second screw which arrests the movement of the former one. These very clever arrangements allow of the slackening of speed at the starting and arrival of the coal tubs at the head of the descent.

The Gramme machines always turn in the same direction owing to the arrangement of the brushes; changes of direction are effected by a cog and two conical wooden pinions, gearing with the same bronze wheel; this change is always made when the machines are at rest and out of gear. The motors turn at a speed varying from 6-10ths to 9-10ths of the speed of the generators, according to whether they are geared or turning freely.

The windlass comprises a cylinder 1·50 metres in diameter, on which are coiled two cables, 15 millimetres in diameter. A brake acts upon this cylinder so as to stop it when the Gramme machines are out of gear. The mechanic being above the machines can see the attaching of the coal-tubs, and also their descent; and besides, a screw with index indicates to him at any moment their exact position.

Near the workman at the windlass are two commutators, which are never to be used for the normal working; this workman communicates with the one outside when he wishes to stop the machine, or send an order to him by means of a telephonic apparatus, known as M. Locht-Labye's *pantéléphone*, an apparatus of great simplicity, and one which, when properly regulated, is not likely to get out of order.

Conductors.—The generating machines are connected with the motors by four insulated conductors; they form two completely independent transmissions, each generator having a connecting wire and a return wire for feeding the corresponding motor.

The insulation of the conductors was in principle the cause of certain difficulties now overcome; they had to be changed three times. They consist now of a strand of sixteen copper wires of 11-10 millimetres covered, first, with two layers of paraffined cotton; secondly, with a layer of gutta-percha 5 millimetres thick; thirdly, with two layers of cloth coated over with Chatterton's composition; and, fourthly, with a stout covering of tarred cotton.

The cable thus supplied by the manufacturer was covered again at the mine with a very adhesive and at the same time highly insulating material composed thus :—

Norwegian tar	57 parts.
Resin	38 ,,
Suet	5 ,,

This coating is laid on in order to preserve the layer of cotton from damp and hot gases. The cable costs 3 francs per metre.

In the shafts and galleries these cables are laid at a distance of at least 20 centimetres from each other. In the galleries they are supported on grooved planks extending from one beam to another of the gallery. If it is necessary to examine or repair them, it is sufficient to remove a few of the planks. The cables then being insufficiently supported fall to the floor of the gallery.

The most highly insulated cables are only placed in the damp parts, about 450 metres, the remaining 750 consisting of a cheaper kind of cable, at only 1·25 francs the metre. The insulation of these cables consists of a layer of paraffined cotton, covered with two envelopes of cloth coated with Chatterton's composition, the whole being protected by a layer of cloth coated with india-rubber.

Passage of the current.—We have seen that in the octagonal machine the collector has four brushes instead of two, as in the ordinary machines. These collectors can be grouped into two distinct pairs, and the current considered as being furnished by two distinct rings. These two rings are grouped *in quantity;* the current supplied by each passes through half the inductors, and the extremities of the wire are attached to the terminals of the generating machines, like two distinct machines grouped in quantity. The corresponding motor is mounted in the same manner; the whole of the electrical circuit is therefore identical with that of two similar dynamo-electric machines also joined up *in quantity.*

The four Gramme machines also form two distinct groups, each having a generator and a motor. Thus each group can be made to work separately, or the two groups together, according to the work to be performed.

Practical results.—MM. Charousset and Bague have made several very interesting experiments relative to the amount of work effected, the speed of the machines, the losses, &c. These experiments have brought forward some curious, almost unknown facts, at which we will take a rapid glance. In the first place they observed what has been thought for a long time, that when the speed of the motor increases the intensity diminishes, and that the intensity increases when the work effected increases. Unfortunately up to the present the experimentalists have only had simple galvanoscopes at their disposal, in which the function which connects the intensity with the angle of deviation is unknown. It was therefore impossible for them to determine the electrical conditions of the working of the transmission. Nevertheless, it is interesting to note the mechanical results. The experimentalists studied first the influence of the charge on the speed of the motors by imparting to the generators a constant speed of 1,280 revolutions, the conductors being in good condition as to insulation. Five series of experiments gave on an average the following results:—

Generators.	Motors.	Charge.
1,280	975	Windlass turning alone.
1,280	880	400 kilogrammes.
1,280	830	800 ,,
1,280	810	1,200 ,,
1,280	780	1,600 ,,

Sometimes a phenomenon was produced, somewhat curious at first sight, but easily explained. The motors, which are identical with the generators as to length and thickness of wires, &c., can, under certain conditions, acquire a speed greater than that of the generators. This fact may be attributed to several causes. The first has to do with the position of the brushes, adjusted with more or less nicety to the relative speeds of the two machines, and to the currents supplied by them; the second relates to bad insulation of the wires; the third to a contact between the spirals of the inductors of the motor, which MM. Charousset and Bague term a shortening of the electro-magnets, the effect of which is to weaken the magnetic field of the motor, and consequently to force it to turn at a greater speed in order to develop the same counter-electromotive force. This remark is of great importance, for it shows what an error can be made by asserting, as certain writers do, that the ratio of the speeds of two identical dynamo-electric machines coupled, one as generator, the other as motor, gives the theoretical *result* of the transmission. This is only true when there is no shortening of the electro-magnets, and when the brushes are well set, conditions difficult to realise in practice, especially with high tensions. Without the reservations we mention, we might find results greater than unity, which is simply absurd.

We will now give the *practical results* of the transmission according to whether the machines worked one, two, three or four coal-tubs on the descent of 110 metres, with an inclination of 40 centimetres per metre. We must here observe that if the figures relating to the results are not very high, it is because the experimentalists have included in the work expended all the passive resistances independent of the electrical transmission. In reality, the work *expended*, as given in the table, refers to the work indicated on the diagram of the steam engine, and the work produced is expressed in kilogrammes of coal drawn up the inclined plane. Thus in the charge of the electrical transmission are included the resistances attributable to the steam engine, the intermediate transmissions, the state of the road, the work expended on the windlass, the friction of the wheels of the coal-tubs on their axles, &c., &c.

These figures are, therefore, really the practical result under certain special conditions, and constitute a minimum which will be far exceeded in practice, when we only attribute to the electrical transmission the losses which legitimately belong to it.

Remarks.—The numbers in columns 1 and 2 are expressed in kilogrammetres. In order to reduce them to *chevaux vapeur*, they must be divided by 75.

Experiments.	Work expended according to the diagram. 1.	Useful Work. 2.	Speed of Generator. 3.	Speed of Motor. 4.	Practical result. 5.
1. Steam engine working freely	312	0			
2. Engine with transmission ...	458	0			
3. Engine with generator, open circuit	518	0			
4. Engine with generator and motor turning freely	530	0			
5. Steam engine with windlass alone	610	0	1,280	975	
6. Steam engine with 1 coal-tub	1,050	128	1,280	880	12·2
7. ,, ,, 2 ,,	1,200	223	1,280	830	18·6
8. ,, ,, 3 ,,	1,370	317	1,280	810	23·1
9. ,, ,, 4 ,,	1,530	400	1,280	780	26·1

The above table shows that the engine with transmission absorbs 458 kilogrammetres per second. When we subtract this number from the total required for the engine when drawing four coal-tubs, the expenditure of work is only 1,072 kilogrammetres per second, and the practical result measured by the weight of coal raised is 37 per cent. It would be still higher and would amount to about 50 per cent. if the work effected were measured, not by the weight of coal raised, but directly on the axle of the motor.

Up to the present only one generator and one motor have been used; the steam engine employed is much too powerful for the result actually obtained, but soon the two generators will be used; the second motor will be adapted to another windlass acting on another descent.

Remarks on the cables.—The cables not covered with gutta-percha answer the purpose very well in the galleries where the air is dry, but become deteriorated in damp places after a month's use. The workmen received shocks on touching them, or on touching the stones of the sides of the shaft in the neighbourhood of the conductors. The lead covered cables, the insulation of which was not sufficiently thick, also gave bad results. The lead melted in certain places, and the cloth coated with Chatterton's composition was burnt at the points where the lead had disappeared. The copper wires showed globules of melted metal. It is probable that derivations to earth were established between the two conductors of the machine. The cables covered with gutta-percha gave the best results, and since they have been employed there has been no hitch.

Summary.—MM. Charousset and Bague have concluded from their observations that electricity employed to transmit force to a distance will replace with advantage, as regards the results obtained, the cost of installation and especially of maintenance, compressed air and mechanical traction, especially in the following cases:—

I. When the mine is not too much impregnated with fire-damp.

II. When the distance between the motor and the receiver is great.

III. When the galleries destined to receive the medium of transmission cables, pipes, or chains, are winding, when only one series of galleries and false shafts meeting at right angles are at our disposal for transmission.

The experiments made at a distance of three kilometres showed that the result varies very little with the distance.

We must avoid dampness as far as possible, as we are free to take the longest path for the cable, and also vibrations which are injurious. When the transmission is effected by friction, pulleys turned perfectly true should be used, and finally the ratio of the speeds of the generators and motors should be maintained at about 0·6, whatever may be the effect to be produced. We see that the installation established at the mines of La Perronière furnishes us with very valuable *practical* information on the installation of transmissions of motive force in mines.

In a future article we shall discuss what has been done at Montceau-les-Mines, and at Saint-Claude for applications of the same kind.

CORRESPONDENCE.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number.

THE CITY AND GUILDS OF LONDON INSTITUTE TECHNOLOGICAL EXAMINATIONS.

To the Editors of The Electrical Review.

Sirs,—Your correspondent "Fareham" seems to consider it an established fact that the "Cowper Street Student" is possessed only of an "examinational" knowledge of telegraphy. Such being the case, it may reassure him to know that the aforesaid student is practically engaged in electrical testing, though not in the Postal service, and probably does as much testing in one day as his unfortunate friend does in a month.

I am, Sirs, faithfully yours,

THE STUDENT.

THE RIVAL TELEPHONE COMPANIES.

To the Editors of The Electrical Review.

Sirs,—Your correspondent "Justice" has a little more of *law* than of *justice* in his composition. He lays down with airy authority that, "any transmitter, combining a diaphragm with a tension-regulator, be it Hunnings', Dolbear's, or Anders', is clearly an infringement." This is surely a little premature. How does "Justice" know that Anders' transmitter is such a combination? Has he ever seen one? Will he describe its parts? If he cannot—and I defy him to do so, because I know he has never seen one—he belies his pseudonym. Again, if his verdict were the voice of justice Reis's transmitter of 1861 would be an infringement of Edison's patent, because it undeniably combines a diaphragm with a tension-regulator. This would be truly "Justice's" justice, to declare that the invention of 1861 was an infringement of the patent of 1877. No doubt Edison is as angry as any one else that an obscure German should have stolen his ideas sixteen years beforehand. It is clearly an in-"Justice" to so great an inventor. But stay, was not the great inventor himself started on the quest by having a manuscript translation of a paper on Reis's Telephone put into his hands by the President of the Western Union Telegraph Company? Does not the great inventor himself say so in Prescott's "Speaking Telephone?" If so, where is the

INJUSTICE?

THE TELEPHONE.

To the Editors of The Electrical Review.

Sirs,—Pardon me for expressing my great astonishment that you should (no doubt unwittingly) have even suggested in your remarks on "The Telephone Industry" to the too timorous, that the United Telephone Company think Edison's single claim covers any semi-conductor placed in between any two points of a telephonic circuit, especially when you have before you the full reports of the evidence and judgments in two suits brought by the United Telephone Company for infringements of Edison's and Bell's patents. The last surviving claim out of thirty in Edison's notorious much-disclaiming patent is in these words:

"In an instrument for transmitting electric impulses by sound the *combination* with a diaphragm or tympan of electric tension-regulators, substantially as hereinbefore described for varying the resistance in a closed circuit, substantially as set forth."

In the Edinburgh case Lord M'Laren used these words:—

"Edison's patent is not for a specific instrument, but for a combination;" and further on he said, "I suppose if Theiler dispensed with a diaphragm, he would be without

the patent, because the tension of the diaphragm is the material point;" to this the Lord Advocate, counsel for the United Telephone Company, replied, 'Yes,'"

Lord M'Laren further said, "Now, as Edison's patent is for a tension-regulator in combination with a diaphragm or tympanum, it follows that the interdict would not apply to the use of the respondent's carbon regulator without a tympanum," and being satisfied that the respondent's instrument involves the combination of a tension-regulator with a tympanum, the complainers (the United Telephone Company) are entitled to protection by interdict under Edison's patent."

In the case decided by Mr. Justice Fry, in May last, the learned Justice said: "The true meaning of the second claim in Edison's patent is the union of a tympan or diaphragm capable of vibrating under the sound-waves with an electric tension-regulator;" and further, "I have concluded that Edison described the essential requisite of his invention to be the combination of a vibrating diaphragm and a tension-regulator," and I have come to the conclusion that the Hunnings transmitter is the combination of a diaphragm vibrating with the voice with a tension-regulator, and therefore is an infringement of Edison's."

To these two decisions I will add that of Lord Cairns (L.R. 1, app. ca. 574) (L.R. 3, app. ca. 34): "If it is clear that the claim is for a combination, and nothing but a combination, there is no infringement unless the whole combination is used, and it is in that way immaterial whether any or which of the parts are used." Those who may believe that two added to two does not make four may also believe that Edison's claim is not limited to "a combination," and that it covers any semi-conductor placed in a telephonic circuit.

I may here add that the judgment of Lord Cairns applies in all its force to Bell's claims of "the combination of an electro-magnet or of a permanent magnet with a plate of iron or steel or other material capable of inductive action." It may not be amiss just now to give publicity to the following law: "Should a person injure the business of another by pretending that that other's manufacture is an infringement of a valid patent when such is not the case, the aggrieved party can obtain costs and damages, and obtain a perpetual injunction restraining him from further intimidation on pain of fine and imprisonment."

I beg however to dissent from your opinion, that this is "an unsatisfactory state of affairs," in regard to the unique claim of Edison's patent; on the contrary, the present state of affairs under the decisions above referred to is perfectly satisfactory, and the use of carbon in tension-regulators *without* a diaphragm is open to all the people of the United Kingdom, as is also the case in a telephone of a magnet in combination with a diaphragm, disc or plate of any material *not* capable of inductive action.

In my transmitters I use various forms of carbon tension-regulators without a diaphragm or tympan, or a colourable imitation thereof, and in my telephones I use various forms of permanent magnets and of electro-magnets without a plate, or disc, or diaphragm of any material capable of inductive action or any colourable imitation thereof, and I challenge any person to gainsay the rights I claim to use those devices, and at the same time I caution all persons against pretending that my inventions, viz., patent 4905, November 9, 1881, and 2259, May 13, 1882 (under which I have manufactured and have sold instruments), are infringements of any valid patent.

If the owner of any valid patent believes that my instruments are infringements of his patents, let him take legal notice forthwith of my avowal or beware of what the law terms "laches."

Yours truly,

W. C. BARNEY.

53, Bernard Street, *August 20th*, 1882.

[Mr. Barney throws out a bold challenge here to the United Telephone Company to contest their exclusive right to carbon tension-regulators. Our correspondent, however, has apparently overlooked the fact that in our article we expressed ourselves as having different views on the matter in question to those promulgated by the United Telephone Company. We rather think that Mr. Barney has erroneously considered "inductive *action*" to be synonymous with "induction."—Eds. Elec. Rev.]

To the Editors of The Electrical Review.

Sirs,—I herewith send to you a continuation of my report of patents for telephone receivers for 1880-1881.

List of British patents for telephone receivers in which a disc capable of inductive action is used in combination with a magnet:—

1880.

No.	Date.	Inventor.	Remarks.
158	January 14th	Crossly	
752	February 28th	Eaton	
1,738	April 20th	Russell	
2,610	June 26th	Gower	
3,473	August 27th	St. George	
3,885	September 25th	A. G. Bell	
4,981	November 30th	Randall	

Telephones without a disc capable of inductive action:—

No.	Date.	Inventor.	Remarks.
2,419 (?)	June 15th	Lockwood & Bartlett	

1881.

Telephones with a disc, capable of inductive action:—

No.	Date.	Inventor.	Remarks.
93	January 8th	Herz	
286	January 22nd	Konigslieb	
542	February 8th	Sax	
1,885	May 2nd	Main	
5,385	December 9th	Foster	
5,430	December 12th	Rose	
5,431	December 12th	Rose	

Telephones without a disc capable of inductive action:—

No.	Date.	Inventor.	Remarks.
1,395	March 29th	Dolbear	No magnet
4,905	November 9th	Barney	
5,028	November 16th	Theiler	

1882.

2,259	May 13th	Barney	

All the patents for transmitters from December 9th, 1876, to January 13th, 1882, have the combination of a diaphragm, with a tension-regulator, except No. 4,905, November 9th, 1881, Barney; and this consists of a number of carbon pencils, the ends of which rest loosely in carbon blocks, which form two sides of a frame, the other two sides being of any non-conducting material, without any back or front.

Yours truly,

COMMON SENSE.

To the Editors of The Electrical Review.

Sirs,—I am delighted that Count du Moncel is beginning to see daylight dawn upon Reis's telephone. He admits that Reis's receiver will receive when the transmitter is good, he admits too that Reis's transmitter will transmit when the receiver is good. The only difficulty now remaining is the difficulty of admitting that a receiver, which will receive, and a transmitter which will transmit, will work together as receiver and transmitter. It is simply a question of fact, Reis and his contemporaries did succeed in transmitting intelligible speech; though they tell us honestly that the vowels were often bad. I have had no great difficulty in succeeding myself, and with reasonable precautions, such as keeping the membrane dry, not shouting too loud, &c., the experiment is simple.

Count du Moncel thinks it "very extraordinary" that such an important discovery did not obtain more publicity. That the lack of greater publicity is "very extraordinary" may be true, but that does not disprove the facts. It only proves that either the fact was so very extraordinary that men did not believe it, ... or else that they did not read German.

But I must be permitted emphatically to differ from Count du Moncel when he charges me with having "not kept to the subject," when I made some remarks on the question of the use of semi-conductors. I quite agree that the question of semi-conductivity has nothing to do with the question. But it was Count du Moncel himself who introduced that very irrelevant point into his preceding letter.

As Count du Moncel continues to reiterate that a loose contact between two good metallic conductors will not produce telephonic effects as well as a loose contact between two imperfect conductors, permit me to reiterate, on my part, what Count de Moncel has neither disproved nor denied, and which he must both deny *and disprove* experi-

mentally before his arguments can have any weight, viz., that if you take an ordinary Blake transmitter, and in place of the bad-conducting button of carbon, put in a bright polished button of the very best conducting metal, silver, the transmitter will transmit speech just as well as before.

I particularly invite Count du Moncel to do me the favour first to *deny*, secondly to *disprove* this result.

Yours faithfully,
SILVANUS P. THOMPSON.

ELECTRIC LIGHTING TENDERS.

To the Editors of THE ELECTRICAL REVIEW.

DEAR SIRS,—In the report of the statutory meeting of the Metropolitan Brush Electric Light and Power Company, Limited, published in your issue of 19th instant, the following question was asked by a Mr. Price: "The Camberwell Streets Committee asked for tenders to light with electricity the streets in their district; only one tender was sent in. Was it theirs? And if not, why did they not tender?" To this question Mr. Hammond replied: "The one tender sent in to the Camberwell vestry was that sent by this company, the Brush." And he further stated, "he Mr. Hammond would be the last man to dodge the question asked," &c., &c., &c. Will you allow me most emphatically to contradict the above? The only tender sent in was sent for the Pilsen-Joel and General Electric Light Company, Limited. The statement was made to me when, as the representative of the company, I handed in the Pilsen Company's tender; and further, the Pilsen-Joel and General Electric Light Company's tender was the only one sent in for another metropolitan district, viz., West Ham. And there are many other cases in which the Pilsen Company is the only company in the field.

Yours respectfully,
JAMES BEATTIE.

Representing the Pilsen-Joel and General Electric Light Company, Limited.

THE BRITISH ASSOCIATION.

BY OUR SPECIAL REPORTER.

SOUTHAMPTON, Wednesday Evening.

THIS morning the 52nd annual meeting of the great scientific congress of the year was opened here amid much enthusiasm. Thirty-six years have elapsed since Southampton was thus honoured, the last occasion being in 1846, when Sir Roderick Murchison presided. Both Southampton and science have advanced, in the generation that has elapsed since that date, by "leaps and bounds," and the very elaborate arrangements for the conduct of the 1882 meeting of the Association may be regarded as the tribute of modern commerce to the scientific knowledge which has so much contributed to its advance. The reception room at the Victoria Hall, which forms the centre of the operations of the Association, has been specially provided with telegraphic, telephonic, and post-office conveniences, such as had not entered into the minds of the scientists of 1846 even to conceive, and the whole town is *en fête* with streamers and bunting, while the arrangements and invitations for visits of pleasure are exceptionally complete and numerous. The congress opens its annual "palaver" under the most favourable auspices, and the 1,070 members and associates who have up to the moment of writing announced their presence may look forward to a pleasant as well as an interesting and instructive *séance*. To-day was mostly devoted to preliminaries. The Council of the Association met at 10 a.m. in the Victoria Rooms, the General Committee followed at 1 p.m. to consider and adopt the council's report, a meeting of Sectional Committees took place at two o'clock, and the skating rink was crowded to the door in the evening to hear the formal beginning of Association work in the shape of the inaugural address by Dr. Siemens, the president for the year. The council, in its report, after noting the corresponding members elected during the year, refers to the loss sustained by the untimely death of Prof. F. M. Balfour, F.R.S., the late general secretary. They request authority for taking steps to ascertain the feeling of foreign scientific associations as to the advisability of holding an international scientific congress, and announced that they have made a contribution of £100 towards the expenses of an expedition for the exploration of the snowy mountain range of Eastern Equatorial Africa. They further recommend the re-election of certain members who retire by rotation. The report was generally approved of by the general committee after a somewhat languid discussion on some minor details. In the evening the Southampton streets began to fill with an unwonted bustle, and amidst a downpour of rain a converging crowd of scientists and local notables, with a large proportion of ladies, surged towards the skating rink, where Dr. Siemens was to take the sceptre from the hand of Sir John Lubbock. The rink was gaily decorated, and in front of the platform a large silk banner waved, on which was embroidered the armorial bearings of the president elect, with his motto, "Aus Eigener Kraft," prominently displayed. In resigning his chair Sir John made felicitous and graceful reference to Dr. Siemens being of foreign birth, and distinctly scored one when he remarked that he was himself the best illustration of the *energy* upon which he believed he was to speak that evening. Dr. Siemens was received with enthusiastic cheers on rising to read his address, and his slow and deliberate utterance was intently listened to during the hour and three quarters that it lasted. At the close of the address a vote of thanks was passed by acclamation on the motion of W. H. Davis, Esq., Mayor of Southampton, seconded by Dr. Spottiswoode, president of the Royal Society. The platform list included the following names amongst many others: Sir John Lubbock; Sir Richard Temple; Sir Frederic Bramwell; Sir William Thomson; Prof. Abel; Prof. A. W. Williamson, Ph.D., F.R.S.; Prof. De Chaumont, M.D., F.R.S.; Mr. Hawksley, C.E.; Mr. John Fowler, C.E.; Capt. Douglas Galton; M. Du Bois-Raymond; Dr. Werner Siemens; Dr. Spottiswoode (President of the Royal Society); M. P. de Tchihatchef, of Florence; Mr. W. H. Barlow, C.E., F.R.S.; Prof. W. F. Barrett, F.R.S.E.; Mr. R. Etheridge, F.R.S.; and Sir Joseph Hooker, F.R.S.

The programme during the session is in outline as follows:—

THURSDAY.—The Sections meet at 11 a.m. In the afternoon the Mayor and Mayoress give a reception at the Municipal Offices. At 8 p.m. the Local Committee give a soirée at the Hartley Institution, which will be lighted by the electric light, supplied by the Edison Company.

FRIDAY.—Sections at 11 a.m. At 3 p.m. the Committee of Recommendations will meet at the Reception Room. In the afternoon the Mayor and Mayoress give a reception at the Municipal Offices; and in the evening, at 8.30, Sir William Thomson, Professor of Natural Philosophy at the University of Glasgow, will deliver a discourse on "The Tides" at the Skating Rink.

SATURDAY.—The Sections meet at 11 a.m. The afternoon will be devoted to excursions—(1) to Alum Bay and the Needles; (2) the New Forest; (3) Netley Abbey and Netley Hospital, where Surgeon-General Holloway, C.B., and the officers of the Army Medical Department will give a garden party to about 300 at the officers' mess; (4) Romsey Abbey and Broadlands Park, where the members will be received by Lord and Lady Mount Temple at tea; and (5) Winchester and St. Cross. At 7 p.m. a popular scientific lecture to the operative classes on "Unwritten History, and how to read it," is to be given at the Skating Rink by Mr. John Evans, D.C.L., F.R.S. The arrangements for this lecture have been carried out by a local working men's committee.

SUNDAY.—At 10.45 the Bishop of Truro will preach at St. Mary's Church (Broad), the members and associates, with the Mayor and Corporation, attending. The same morning, at 11, the Rev. C. Pritchard, Savillian Professor of Astronomy at Oxford University, will preach at All Saints' Church (Evangelical).

MONDAY.—Sections at 11 a.m. At 3 p.m. the officers for 1883 will be elected and the place of meeting in 1884 fixed. In the afternoon Canon Basil and Mrs. Wilberforce give a garden party in the Deanery grounds. At 6.30 for 7 o'clock a special Provincial Grand Lodge of Hants and Isle of Wight Freemasons will be held at the Masonic Hall in Albion Place, opposite All Saints' Church, in order to welcome Freemasons visiting Southampton. At 8.30 p.m. in the Skating Rink, Mr. H. N. Mosely, M.A., F.R.S., Linacre Professor of Human and Comparative Anatomy at Oxford University, will deliver a discourse on "Pelagic Life."

TUESDAY.—Sections at 11 a.m. At 3 p.m. meeting of Committee of Recommendations; at 8 p.m. a soirée at the Hartley Institution, at the invitation of the Mayor and some members of the Corporation.

WEDNESDAY.—At 10 a.m. meeting of Committee of Recommendations; at 1 p.m. the General Committee will meet at the Skating Rink to receive the report of this Committee of Recommendations; and at half-past 2 in the afternoon the concluding meeting of the Association takes place.

Thursday will be devoted to excursions—(1) to Salisbury and Stonehenge, or Wilton; (2) Ryde, Brading (for the Roman Villa), or Waitecliff; and (3) two marine excursions, including Portsmouth.

The Queen has assented to an application for the members of the Association to visit Osborne after her departure for Scotland, which will probably be about Friday next; and the Union Steamship Company will issue invitations for a whole day marine excursion on their steamer *Pretoria*.

By telegram we learn that on Thursday the business of the Association commenced in earnest, and the section of Biology in particular has not proceeded further than the presidential address. In two of the departments a respectable amount of work, as represented by the papers read, has been got over up to the hour at which sectional meetings stood adjourned. The number of tickets issued at 3 p.m. was 1,150, which it is understood contrasts somewhat unfavourably with the issues of recent years, but the attendance of the various departments has been fully up to the usual average.

The numerical honours of the day may be said to have fallen to the mechanical science section in which Mr. John Fowler delivered his presidential address to a crowded house.

Mr. Fowler reviewed the progress of engineering science in a graphic and humorous fashion, the audience being particularly tickled by the contrast which he drew between the performance of the engines at the opening of the Liverpool and Manchester railway in 1830, when thirty-three miles were got over in five hours with the aid supplied by passengers walking up all the inclines; and the mile a minute speed to which the present generation is so accustomed.

Dr. Siemens, in proposing the vote of thanks, rather complained that the President had omitted to discuss the progress of applied electricity, but the address may be looked at as one of the most comprehensive of the day.

Mr. Baker followed with a most exhaustive account of the Forth Bridge, which manifestly interested his auditors to no common degree.

Lord Rayleigh led off the Mathematical Section by a suggestive little address respecting the qualifications required for, and the dangers to be avoided in, scientific research. The large portion of the audience who remained to hear Mr. Darwin's paper on Gravitation Disturbance were well rewarded both by the paper itself and by Sir William Thomson's interesting criticism. The succeeding subjects covered a wide field, from the recent Eclipse and Spectrum Analysis to the Velocity of Light and "Some Matters concerning the Sun." The Chemical Section, after Prof. Liveing's address, was poorly attended, and the same may be said of the Geological and Economic departments, though the names of Leone Levi, Mr. Abel, and Mr. Etheridge guaranteed the quality of the fare presented. To-morrow may be regarded as the steadiest working day that the Association will have at its disposal. Saturday's and next week's holidays must distract the attention of even *savants*. This afternoon has brought us a large accession of names of note, including Dr. Gladstone, Profs. Adams, Cayley, Milne, Stewart, and Schuster, Sir Henry Bessemer, Mr. Glaisher, and others. An element of discomfort is the threatening weather, but it is hoped that the success of the gathering will not be thereby seriously disturbed.

NOTES.

Erratum.—Page 131, column 1. Maxim light—read "Edinburgh" for "Glasgow."

Danger from Electric Lighting.—We are informed upon good authority that the two deaths occurring recently in the Tuileries were occasioned by the current from an alternating current Siemens' dynamo-electric machine.

Le Ménstrel states that the electric light nearly caused a conflagration at the Paris Opera last week during a performance. The current being too strong, the wires became red hot, and their gutta-percha covering being quickly destroyed, the adjacent inflammable material began to smoulder, and the services of the firemen had to be called into requisition.

Electric Light Installations.—We are glad to observe that signs of improvement are visible in the erection of electric light apparatus. Mr. Dickson, in addressing those present at the first general meeting of the Brush Electric Light and Power Company of Scotland, said, in reference to the lighting of Waverley Station, "The North British Company are quite aware of whom they are dealing with. They only had 16 arc lights last year, and they have now given us an order for double that number. We are carrying out that order with an efficient staff and proper instruments, so that the sort of slipshod way in which it was done before will not recur in the management of your board of directors."

Secondary Batteries or Accumulators.—The *New Haven Evening Register* of America in speaking of the "Sutton" secondary battery says: "This form of battery was improved upon by Charles E. Buell of this city, who employed common lead shot, coated with mercury, and placed in a porous cup. He put this cup in a glass cell and surrounded it with a coil of copper-wire cloth, which served as the positive electrode. The employment of shot and wire cloth furnished the greatest surface in a given weight and constitutes a form most easily made. Mr. Buell verifies the published statement of Mr. Sutton that a cell four inches high and four inches in diameter will keep a No. 28 iron wire at red heat for two hours; that it is more constant, and does not polarise during discharge, as does the Faure battery. It weighs very much less, occupies less space, and costs less than the Faure battery of like force, and is untrammelled by patent rights."

The Electric Light in Holborn.—Information has been sent to us that the Pilsen-Joel, and General Electric Light Company has secured the following orders:—At the Inns of Court Clothing Company and the Bon Marché Clothing Company, respectively, four Pilsen arc lamps, giving a stated luminosity of 2,000 candles each. These will be worked from the station in Whetstone Park to which we have already referred.

The Pilsen-Joel and General Electric Light Company.—We believe that the statutory meeting of this company will shortly be held, and it will be interesting to the shareholders to know what progress has been made since its formation. We were under the impression that the system of lamps and machines worked by this company would give it a leading position in the electric lighting world, and we still hold the same opinion, but for reasons we cannot fathom the operations of the Pilsen-Joel Company do not appear to be so energetic as promised in the beginning. This, however, it is to be hoped will soon be remedied, if the directors have any wish to meet the demands likely to be put upon their resources during the forthcoming winter. It is evident that the working arrangements of this company are not yet all that could be desired; in fact, it is but too apparent that there is considerable room for improvement. We would strongly urge upon the directors, in their own interests and in those of their shareholders, to give the subject their earnest and prompt attention. With their good system and business management the Pilsen-Joel Company should be second to none. Commercial ability solely has made one prominent company the enormous success it is.

New Method of Insulating Electric Wires.—M. H. Geoffroy has just presented to the Academy of Sciences a process of insulating conducting wires, with the object of preventing all chances of fire, even when the wires are in contact with combustible materials. This process consists in covering the conducting wires with a coil of asbestos fibres and then placing them in a leaden tube as is generally done; the wire can be entirely volatilised without the spark communicating with the outer coverings, the lead not showing any signs of fusion. With a powerful current the volatilisation of the wire lasts the tenth part of a second; the copper being once burned the current is naturally interrupted. Besides, the electrical insulation is satisfactory.

Transmission of Electricity for Lighting Purposes.—At the meeting of the Metropolitan (Brush) Electric Light Company, a full report of which appeared in the Electrical Review of last week, Mr. Hammond said, in the course of his remarks, that the Charing Cross Railway Station was lighted from the Brush Company's station at Lambeth, *a thing which was only possible with the Brush system.* Mr. Hammond had evidently overlooked the lighting of Victoria (underground) Station by the Jablochkoff Company from their station on the Thames Embankment. He should also be aware that it is quite *possible* for the British Electric Light Company, Messrs. Siemens Brothers, the Pilsen-Joel, &c., Company, and others to extend their systems to long distances from a central station if they choose to construct their machines so as to give a dangerously high electromotive force. At the same meeting Mr. Wm. Ladd spoke in much the same strain as Mr. Hammond, and if his remarks could be looked upon as true, then the Brush machine is superior in every way to others.

The Electric Lighting Bill.—The Board of Trade notify that the rules with respect to applications for licenses under the Electric Lighting Act of 1882 may be obtained from P. S. King, King Street, Westminster; Knight and Co., 90, Fleet Street, E.C.; Shaw and Sons, Fetter Lane, E.C.; Hadden, Best and Co., 227, Strand, W.C.; A. and C. Black, Edinburgh; and A. Thom and Co., Dublin.

The Lighting of the Manchester Royal Exchange by the British Electric Light Company, Limited. (Extract from the *Manchester Courier*, Tuesday, August 22nd, 1882).—"It will be remembered that a short time ago the directors of the Manchester Royal Exchange decided to test the capability of the electric light in the illumination of the building, and last evening an experiment was made in the lighting by electricity of the interior of the structure with most satisfactory results. At the same time two lamps were brought into operation on each side of the portico in Cross Street, the effect being that they completely eclipsed what had been up to then considered the brilliant light of the recently introduced patent gas lamps in the adjoining part of Market Street."

Spread of Electric Lighting.—At the last meeting of the Fulham District Board of Works the seal of the board was affixed to an agreement with the West Middlesex Electric Light Company empowering the company to lay wires enclosed in pipes under the footways throughout the parishes of Fulham and Hammersmith. The distance of the roads in the district is 39 miles, and the number of houses 29,000. It is proposed to erect at suitable points central stations upon a large scale within the two parishes for the purpose of generating the electricity. For street lighting Brockie's arc lamps will, at present, be fixed, and for shops and private houses the British incandescent lamp. The light is already being extensively sought after by many of the largest tradesmen in the district, who are desirous of using it. The Brush Midland Electric Light Company (Limited) have entered into a contract for the lighting of the town of Cleethorpe for the next three years. The Severn Tunnel Works, Monmouthshire, are also being lighted on the Brush system, and preparations are being made for extensive lighting at Bristol, Newport, and Cardiff during the coming winter. At St. Martin's-le-Grand the Edison incandescent system has been fitted up in the newsroom. The current is sent from the company's central station on Holborn Viaduct, a distance of about half-a-mile. At Southampton the theatre of the Hartley Institution is being illuminated by this company's system during the meetings of the British Association. At the forthcoming North East Coast Exhibition at Newcastle, the Gülcher, Hammond, and Pilsen-Joel Companies are to display their respective systems. In Scotland there is also evidence of advance. In a recent issue we said the North British Company had decided to extend the electric light at their Waverley Station, Edinburgh. We learn that the number of lamps is to be increased from sixteen to thirty-two and that the cost to the company shall not exceed what they have hitherto paid for gas; which, it may be added, was manufactured by themselves. Each lamp is of 2,000 candle-power, and its cost is put down at 2½d. per hour. In addition to this undertaking, the Scottish Brush Electric Light and Power Company are making arrangements for the lighting of Portobello station and goods loading depôt (one of the busiest stations on the North British system) by electricity at gas rates. A number of other stations are mentioned, among them Dundee, Arbroath, and Inverness. Private firms throughout the country are making inquiries and inviting tenders.

In New York wires have been laid down in the streets by the Edison Company and everything is on the eve of completion, so that by the first week in September a very considerable portion may be wholly lighted up by electricity.

Patents for Incandescent Electric Lamps.—We have received information that the British Electric Light Company have recognised the fact of their infringement of the Edison patents for electric lighting by paying a substantial sum as royalty to the Edison Electric Light Company, Limited. We are advised that this infringement refers only to a feature in the construction of the lamp.

The Government and the Telephone Companies.—We extract from the *Times* the following letter, in reply to one signed "Electrician," part of which we published last week:—

Sir,—Your correspondent "Electrician" states the case of the Telephone Companies' so-called "free competition" well, so far as he goes. But in your article in the *Times* of to-day you speak of "enforcing, in the interests of the Crown and the public, only such conditions as are necessary to protect the revenue and to insure to the Post Office the means of competing freely on its own account."

Note the words, "only such conditions." One of the conditions is that the companies to whom licenses are granted shall supply the same class of instrument used on their lines for use by the Post Office in the same district for which the licence is granted. The price of these telephones to be fixed by arbitration.

The only companies to a certain extent exempt from this obligation to supply telephones are the United and the National.

Another condition is that the telephone companies, before erecting any line, shall supply to the engineer of the Post Office a plan showing how that line will run; and if the engineer thinks that it will interfere either with the existing Post Office wires or with any route they intend to lay out in future, the consent is refused, after the telephone company has had all the trouble and expense of obtaining way-leaves, &c.

In addition to the royalty of £2 per subscriber, the Post Office charges private companies a royalty of about £1 a mile per subscriber for communication between one centre and another; and before granting permission to make the connection makes the telephone company gurantee a *minimum* of eight subscribers. Thus, between Leeds and Bradford, a distance of only nine or ten miles, the Telephone Company is charged £10 per subscriber.

Is this fair competition? the Post Office paying no royalties on instruments and no tax to Government.

Faithfully yours,
FAIR PLAY.

London, *August 17th.*

The Otranto-Corfu Cable.—On Wednesday, the 16th instant, Mr. W. A. Killingbeck, the electrician to Henley's Telegraph Works Company, returned to England after effecting the repairs of the above cable. He left this country on the 10th of July, and commenced operations about a week afterwards. The fault was found about 1½ knots from the Otranto end of the cable, and the repairs were completed in three days. We understand that the cable, which was manufactured by Messrs. Glass and Elliott is, for a submersion of over 20 years, in excellent condition. It will be remembered that we noticed the departure of the s.s. *Caroline* on this expedition, in our issue of July 8th. We hear that the same telegraph ship is now chartered by the Eastern Telegraph Company for their cable operations in the Mediterranean.

Underground Cable between Paris and Marseilles.—We read that cast iron pipes are now being made to receive the underground telegraph cable which in a few months will put Paris in direct communication with Marseilles. One hundred and fifty navvies are engaged in this work, which is being prosecuted from both ends along the right bank of the Rhone, and following the main roads. The work is pushed forward with vigour, and it is proposed eventually to connect this cable, which will traverse France from north to south, with the cables of the Mediterranean and Atlantic.

Central and South American Telegraphic Company.—We note the following in the *Panama Star and*

Herald, dated July 13th: "A cablegram received in this city announces the death at Punta Elena, Ecuador, of Mr. MacLachlan, an operator of the Central and South American Cable Company, who left for that point per *Casma*, on her last trip south. The deceased gentleman had formerly been in the Atlantic cable service, and only arrived here per *Bolivia*, on the 27th of last month. It appears that in riding from the port, Mr. MacLachlan fell from his horse and fractured his skull, dying from the effects late on the 6th inst. Prior to his departure from Panama, he had mentioned the fear he felt at having to ride some distance, never having mounted a horse before in his life, and his melancholy death affords another proof that sometimes the shadow may unwittingly be felt of a coming event. There is no operator for the telegraph company at Punta Elena, and the office will consequently have to remain in the contractor's hands, even should the cables be turned over to the company.

India-Rubber Production in Brazil.—A pamphlet, lately issued in Rio de Janeiro by Senhor Pimenta Bueno, calls attention to the great importance of this product, and the influence it has had on the commerce of Para, the value of whose imports and exports has risen from 26,332,580 mils during the years 1849-1854, to, in 1874-1879, 108,702,684 mils, or fully four times as much during the last five years, while the revenue of the city has increased during the same period from 4,368,527,650 reis to 17,825,895,567 reis, having during the five years previously, say, from 1869 to 1874, reached the large sum of 21,245,591,032 reis. To show the proportionate value of india-rubber, as compared with other exports, the return for 1879-1880 apportions them as follows:—

India-rubber	12,242,500	mils
Castanha nuts	1,473,800	,,
Cacao	1,032,500	,,
	14,748,800	,,

On the other hand, the total exports from the two provinces of Para and Amazonas during the same period was 15,497,600 mils, a striking proof of the position held by india-rubber. It is further stated, that "the provinces of Para and the Amazonas import sugar, coffee, Indian corn, beans, and even mandioca flour." Again, the writer of the pamphlet states that india-rubber occupies the third place in the exports of the empire after coffee and sugar, and yet how few of our readers are probably aware of this fact. Para occupying the extreme northern limits of the empire, with its vast river, the Amazon, flowing past.

The writer shows how, owing to the destructive manner in which the india-rubber trees are cut down, this valuable branch of industry is threatened with serious diminution, if not almost extinction, and urges that means ought to be taken to regulate the cultivation and supply of this valuable article, a conclusion in which most people must agree who feel an interest in Brazil, as well as the great river which gives access from Para to the Andes, and whose banks are covered with primeval forests, many as yet almost untrodden by the foot of man.

A great increase in the value of the article is exhibited, that current being 3,100 reis per kilogramme for fine quality, whereas in the year 1825 it was only worth 300 reis the kilogramme. It may also be noticed that india-rubber contributes 25 per cent of its value to the general and municipal taxes of Para.

Magnetic Units.—We are promised shortly an article on magnetic units by Professor Silvanus Thompson, including an account of a magnetic measuring instrument which he has lately devised. This instrument is, we believe, almost identical with that described in our columns on 12th August, by Mr. F. J. Smith. It is, however, only fair to Professor Thompson to state that he mentioned the existence of his instrument to us before the appearance of Mr. Smith's description.

Personal.—Lieut.-Colonel C. E. Webber, R.E., the President of the Society of Telegraph Engineers and of Electricians, has been suddenly called to Egypt, having been appointed A. Q. M. General on the staff of Sir Garnet Wolseley. We believe the Lieut.-Colonel left England on the 18th instant. Sir Garnet has already had the advantage of Lieut.-Colonel Webber's assistance during the South African campaign of 1879.

We trust that before the meetings of the Society of Telegraph Engineers and of Electricians commence again, the Egyptian affair will be settled and the president once more amongst us, completing the term of office which he has up to the present so worthily and energetically filled. Lieut.-Colonel Webber may rest assured that his career in Egypt will be eagerly watched by many outside military circles.

Burglars and Electricity.—Mr. W. H. Akester, F.S.A., electrician to the Universal Electric Company, Glasgow, has been much annoyed for some months past by midnight burglars attempting to break into his residence at Balvaird, Rutherglen, near Glasgow. He has therefore been under the necessity of devising a plan of adapting electric bells so as to warn him of the approach of burglars, and it has proved at once effective and inexpensive. Late on Wednesday night last week, after the family had gone to bed, a couple of burglars opened the gate, which immediately caused the bell in Mr. Akester's bed-room to ring. From the indicator he knew that they were just entering by the gate. Mr. Akester immediately got out of bed and dressed in haste, by which time the bell rang again, the indicator showing that the thieves were at the front bed-room window, on the ground-floor. Thinking that the servant had not retired for the night, and knowing that the bell is sometimes inadvertently rung when closing the shutters of the window he called over the stair to see whether such was the case. No response was made and he proceeded to the point indicated. The burglars, who by this time had obtained access to the bed-room by the window, must have heard his voice, for, without taking any booty, they immediately cleared the window, took to their heels and decamped. Mr. Akester has had no further annoyance from them since. It is obvious that the application of electricity in the direction indicated above may be greatly extended.

A New Theory.—Those who attended at the City Hall, Glasgow, on the afternoon of Sunday last, heard a new theory propounded by Dr. Hately Waddell on the relationship of electrical science to his Satanic Majesty. Choosing for his text the words, "And I saw an angel come down from heaven having the key of the bottomless pit and a great chain in his hand, and he laid hold of the dragon and bound him a thousand years and cast him into the bottomless pit," Dr. Waddell explained that the terms dragon and devil were figurative expressions for falsehood, ungodliness, &c., and proceeded to ask if our successors on this mundane sphere were in the future to be continually looking up to the clouds for the angel spoken of in the text to come down and bind the devil for a thousand years. If ever angel, Dr. Waddell said, came down from heaven to earth for a work like this it was the angel of electrical science. It came direct from heaven. If such an angel brought a chain in his hand it was the telegraph wire and the submarine cable, coiled up and carried on his arm. If ever such an angel had such a key as spoken of in the text, it was the submarine telegraph. Although a thousand years had not yet been accomplished, they had begun, for of all agencies which human ingenuity, human industry, and courage ever carried out, or will ever carry out, this very agency of electric communication from door to door and from one end of the earth to the other, across deserts, over mountains, and under rivers, and deep oceans like the Atlantic and the Pacific, was the most wonderful. It was unquestionably a revelation from heaven. This was the mode of communication by which the devil himself was to be circumvented, surrounded, bound, and imprisoned, so that he dare not at the peril of his existence utter a lie in the hearing of mankind. If there was any place deeper than the bottom of the Atlantic in this terrestrial globe it would soon be found; and the devil, the father of falsehood, fraud, and imposition, would be sent headlong into perdition. Just in proportion as electricity circled the earth just in that proportion would the devil be defeated!

[If any incentive to work were required in the present state of electrical knowledge here is the golden opportunity.

There is something pleasant in the thoughts that electrical men have contributed in no small way to their own salvation without having been conscious of the fact until brought home to them by Dr. Waddell, "*which is tidings of comfort and joy.*"]

Electrical Phenomena in the Alps, &c.—Mr. A. S. M. Buttemer, in a letter addressed to the *Times*, and dated Lausanne, July 26, gives the following description of some electrical phenomena observed by him during a thunderstorm which took place on the Matterhorn :—"The morning had been fine and warm, but about noon snow fell. On the top the sun came out, and the view on the Italian side was perfectly clear. About five minutes after commencing the descent the sky suddenly became dark, and snow fell in such density that, as one of our party described it, you could grasp a handful from the atmosphere. A peal of thunder made our guides hurry on. Directly afterwards we heard a sharp crack resembling the report of a rifle, and each of us felt a slight shock in the head. A peal of thunder followed instantly. The guide, who was carrying an ice axe, threw it away in alarm. A second and much louder crack followed in about a minute, and we all experienced a powerful shock. The guides felt it in the head, and one of them complained of a severe headache for the rest of the day. My wife described it as passing through the body. I felt it entirely in the knees, which seemed as if momentarily dislocated. Thunder followed immediately as before. After this there were a few distant peals of thunder, and in an hour the snow ceased and the sun came out."

A number of years ago M. Fournets, in an interesting communication brought before the members of the French Academy, showed that on the Alpine and Jura mountain chains exist points which are remarkable for electrical phenomena. The following are some of the effects related in the paper :—

Spontaneous Illumination of the Rocks on Mont Blanc.—During the night of the 11th of August, 1854, Mr. Blackwell was stationed in the Grand Mulets, when the guide, M. Couttet, went out of the little hut about eleven o'clock, and perceived that the edges of all the rocks around appeared as if on fire. He mentioned the fact to his companions without delay, and they all witnessed the phenomenon in question. A storm raged at the time, and under its electrical influence all the edges of the mountains appeared illuminated. Moreover, the clothes of the guides became literally covered with electric sparks, and when they raised their arms into the air their fingers became phosphorescent. At the same time (eleven o'clock at night) heavy rain fell at Lyons, with some thunder in the south-west, and the whole day previously the weather had been very stormy. The same guide, M. Couttet, of Chamounix, when he ascended Mont Blanc on the 25th of August, 1841, in company with M. Chenal, was overtaken by a storm which was extremely dangerous to them, for they were completely surrounded by the lightning. All the rocks and stones about the spot emitted numerous electric sparks, whilst the summit of Mont Blanc and the sky above were perfectly serene.

Electricity on the Breven.—The curious phenomena witnessed by De Saussure, Jalabert, and Pictet on the Breven (altitude 2,520 metres) in 1767 is thus related :—"The weather was very stormy. The travellers had only to extend their fingers or to raise their hands in order to feel a peculiar pricking irritation at their extremities. Pictet was the first to remark this, but the phenomena became in a short time much more intense, and was accompanied by a kind of hissing or buzzing noise. Jalabert, whose hat was ornamented with gold braid, according to the fashion of the period, heard a fearful buzzing noise around his head. Some electric sparks were obtained when the others approached their hands to the gold button on M. Jalabert's hat, or to the iron tip of his walking stick. The storm becoming very violent, the three travellers found it necessary to descend some thirty yards lower down on the mountain side, when they no longer felt these electrical effects.

Electric Snow on the Jungfrau.—On the 10th July, 1863, Mr. Watson and several companions visited the Col de la Jungfrau. The morning had been very fine, but on approaching the Col they perceived that heavy clouds had collected there, and as soon as they reached it the whole party was plunged in a strong gust of wind, accompanied with hail. Forced to return they mistook the road, and wandered for some time in the Latoch-Sittel. At this moment a formidable peal of thunder burst forth, and soon afterwards Mr. Watson heard a kind of hissing noise emanate from his stick. It was like the noise of a kettle boiling on the fire. The sticks and axes carried by the others presented the same phenomena. One of the guides took off his hat, exclaiming that his head was burning; and, in fact, his hair stood on end, like that of Mr. Watson's. The snow during this time emitted a sound similar to what might have been produced by a rapid shower of hailstones. No phosphorescent phenomena were observed, but it is highly probable that lights would have been seen if this had occurred at night. Many of the excursionists received electric shocks more or less intense. At about half-past twelve o'clock the clouds passed away and the above effects disappeared, after having lasted some five-and-twenty minutes.

Electricity on the Piz Surley.—On the 22nd June, 1865, M. A. de Saussure ascended the Piz Surley, starting from Saint Moritz in the Grisons. The Piz Surley is a granite mountain some 2,300 metres high. About one o'clock in the day small hailstones fell abundantly, and a kind of sleet covered the rocky needles and the snow-capped peaks around. The cold increased as our observer arrived at the summit of the Piz Surley about half-past one o'clock. The sleet and hail becoming more abundant, it was determined to make a halt, and to lunch under a pyramid of dry stones which crowns the peak. Resting his stick against this rough construction, Saussure felt a sharp pain in his left shoulder; it was like a pin penetrating slowly into his flesh. Thinking that a pin had found its way into his cloak, he took it off, but the pain only increased, and spread from one shoulder to the other. He then took off his coat, and whilst doing so, discovered the electrical nature of the phenomenon by the peculiar buzzing noise which issued from his stick. A little time afterwards he saw electric radiations emanate from his fingers when he raised his hands in the air. His companions noticed the same curious effects. A thunder-clap towards the west warned them that it was time to leave the summit, and they descended some hundred yards down the mountain. These various effects diminished as the travellers descended, and they stopped when their sticks ceased making any noise. The same day a violent storm broke over the Bernese Alps, and a young English lady on her wedding tour in these mountains was killed by lightning.

Field Lightning in the Jura.—Sometimes certain pasture grounds in the Jura district are seen literally covered by flashes of lightning, hence the phenomenon has been denominated *field lightning*. On the 25th August, 1865, between nine o'clock and mid-day two successive storms were noticed by M. Quiquerez, at Porentray, near Courtavon, at the foot of the Jura. At three o'clock in the afternoon a third storm arose, and the clouds were observed to be very low. Electrical effects manifested themselves with fearful intensity on the entire surface of the fields. The electric flashes succeeded each other with extreme rapidity, and formed long luminous tracts along the pasture land, instead of through the air. The general noise was such as to prevent isolated explosions or decrepitations being heard. No rain fell; but the observers of this strange phenomenon were almost in the cloud itself, and the ground was very wet by the rain which had fallen in the morning. The same day, some three or four leagues to the east of Morimont, along the same chain of mountains, but a few minutes later, fearful lightning played along the surface of the fields and pasture grounds, as if the herbage had been on fire. These storms spread as far as Lyons. Phenomena similar to what has just been narrated are occasionally observed at the surface of lakes and ponds. Arago tells that a farmer of Parthenay, in Vendée, saw a vivid flame spread over a pond during a storm which occurred in the night of the 4th September, 1767, and the next day all the fish in the pond were found dead upon the surface of the water. Something very similar happened on the 2nd August, 1850, at eight or nine in the evening on the Lac de Moret, and more recently on the Lac de Bienne.

The Post Office and the Telephones.—With respect to the letter of "Fairplay" which we publish in our

"Notes," and referring to that portion of his letter concerning the charge of £10 per subscriber between Leeds and Bradford, we may remind our readers that the Post Office Private wire rentals for the provinces—are, for the wire over house, or underground £7, and for roads £5, per mile per annum. If a double wire is rented the charge per mile is £13 10s. Hence if a single wire is used between Leeds and Bradford the charge will be £70, if a double wire £135. Notwithstanding the "conditions" by "Fairplay," there is evidence from all parts that the development of the telephone has received a great impulse from the Postmaster-General's statement that there should be fair competition.

NEW COMPANY REGISTERED.

MEDICAL CONSTANT CURRENT ELECTRIC COMPANY (LIMITED).—Capital, £100,000, in £1 shares. Objects: To purchase for £48,000 in fully paid shares the letter patent, No. 3443 of year 1882, for an improved medical battery. Signatories (with 1 share each): *H. Stanbrough, Gipsy Hill; *J. Wild Hulseberg, M.R.C.S., Upper Norwood; *William Allison, 22, Grosvenor Mansions; *Major-General C. J. Richards, Southsea; *Major A. Campbell-Walker, Walton-on-Thames; C. F. Tombs, 38, Lombard Street; E. Erskine Scott, 38, Lombard Street.

Directing qualification, £250, in shares. Remuneration, £150 per annnum to each director, with an additional £150 to the chairman. Registered 17th instant by W. T. Manning, 2, Westminster Chambers, Victoria Street.

* Signatories denoted by an asterisk are directors.

NEW PATENTS—1882.

3869. "An improved dynamo-electric motor engine." E. DESFOSSÉS. Dated August 14.

3881. "Electric lamps and conductors therefor." F. R. WELLES. (Communicated by C. E. Scribner and W. R. Patterson.) Dated August 15. (*Complete.*)

3882. "Telephone apparatus (switches)." F. R. WELLES. (Communicated by C. E. Scribner and W. R. Patterson.) Dated August 15. (*Complete.*)

3893. "Secondary or storage batteries." H. J. HADDAN. (Communicated by H. Aron.) Dated August 15.

3906. "Electric lamps or lighting apparatus." W. R. LAKE. (Communicated by P. Tihon and E. Régard.) Dated August 15.

3912. "Strengthening and checking electric currents." P. ADIE and W. S. SIMPSON. Dated August 16.

3941. "Secondary batteries, and methods of constructing the same." N. C. COOKSON. Dated August 17.

3946. "Receiving and recording telegraphic signals." B. H. CHARNEROY. Dated August 17.

3949. "Means or apparatus employed in or for supplying electricity for light, power, or other purposes." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 17.

3950. "Dynamo-electric machines, or electric generators, and apparatus connected therewith." S. Z. DE FERRANTI and A. THOMPSON. Dated August 17.

3951. "Improvements in water-motors, and in utilising the force of rivers and streams for the purpose of generating electricity, and in the means employed therefor." S. S. ALLIN. Dated August 18.

3955. "Incandescing electric lamps, and means connected therewith." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 18.

3961. "Secondary batteries." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 18.

3964. "Improvements in secondary or storage batteries, and apparatus connected therewith." H. T. BENNETT. Dated August 18.

3971. "Improvements in insulating compositions to be used in coating or covering wires and appliances employed in conducting electricity for telegraphic, telephonic, lighting, and other purposes." C. J. ALLPORT and R. PUNSHON. Dated August 19.

3974. "Dynamo electric power creating machines." J. E. T. WOODS. Dated August 19.

3975. "Secondary batteries and electric accumulators." J. E. T. WOODS. Dated August 19.

3976. "Electric lights." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 19.

3980. "Improvements in the insulation of wires and other electric conductors used for the production and transmission of electric currents." J. H. JOHNSON. (Communicated by I. M. Hirsch.) Dated August 19.

3982. "Electric signalling apparatus." R. H. BRANDON. (Communicated by H. W. Southwood.) Dated August 19. (*Complete.*)

3991. "Manufacture of incandescing conductors for electric lamps." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 19.

3995. "Underground conductors for electrical distribution." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 21.

3996. "Dynamo and magneto-electric machines for regulating the generation of current by such machines." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated August 21.

4003. "Improved safety devices for use with electric apparatus or conductors designed chiefly for preventing or diminishing fire risks." S. P. THOMPSON. Dated August 22.

4005. "Manufacture and composition of non-conducting tubes for electrical and other useful purposes. J. C. MARSH and R. J. SMITH. Dated August 22.

4025. "Working gear and appliances used in electric lighting." K. W. HEDGES. Dated August 22.

4034. "Generation, storage, distribution, regulation and utilisation of electricity and apparatus or means therefor." J. S. WILLIAMS. Dated August 22.

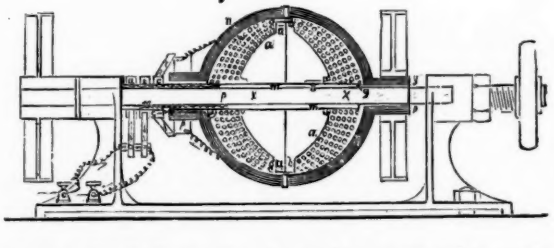
ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

5477. "Electric lamps." W. R. LAKE. (A communication from abroad by C. F. de la Roche, of Paris.) Dated December 14. 6d. Relates to improvements in electric lamps or lighting apparatus. According to the said invention, the inventor develops the voltaic arc in the interior of a chamber or space provided in a block of any kind of refractory material, having in its walls or sides, openings in the form of the frustum of a cone, so as to allow the light produced to emerge in determined directions.

1882.

157. "Apparatus for electric lighting." G. HAWKES. Dated January 11. 8d. Relates to the construction of electric lamps, with a view to simplify the mechanism, shunts, and regulating gear in connection therewith. In constructing an electric lamp according to this invention, the inventor employs mercury or weights for the purpose of forcing the lower or negative carbon by means of tubes into proper position with the upper or positive carbon, and he regulates the ascent of the lower carbon by the varying action of a magnet or solenoid, which is placed in a branch circuit in the lamp. The duty of this magnet is to operate on a movable armature or keeper combined with a clutch or jam ring, turning on two centres, together with a spring descending from the outer one of two screws which operate from the upper one of two metal plates in the negative circuit. This spring in the first instance by its operation prevents the ascent of the lower or metal carbon, but gradually yields and allows it to approach towards the positive carbon, staying the progress, however, of the lower carbon at a proper distance to form the arc and according to the strength of the branch magnet. This action continues until both carbons are consumed or the current be shunted to the next pair.

169. "Electro-motors and dynamo-electric machines, &c." H. S. RAISON. Dated January 12. 8d. According to this invention the inventor has endeavoured to make the inducing electro-magnet and the armature both active by taking the form of two balls of preferably spherical or oval form, one rotating inside the other. The outer one revolves in an opposite direction to the inner one, but there may be several, that is to say, supposing that five globular electro-magnets of this form were employed, three may be connected together and revolve in one direction, and the remaining two intervening ones, also coupled, revolving in the opposite direction. The annexed figure



represents a longitudinal section of a machine constructed in accordance with the invention. *a a* is the inner core of cast iron, with projections, a^1 a^1, forming pole pieces. This core is cast in two halves, and is mounted on the shaft, *x*, being fixed thereon by a key, *n*, and steady pins, *b*. *m* is a fixed brass tube, with a groove cut therein to receive the wires, *w w*, and conduct them to the commutator. The face, *g*, and collar, *p*, serve as a guide against which the outer bearings revolve. The core of the outer coil is preferably built up of segments, n^1 n^1, which may be wound separately before fixing in position. The two segments which form the bearings are preferably of brass or other non-magnetic material. A number of openings are left which admit of air circulation to keep the machine cool and to lessen the heating or induction currents, or the core may be made of some non-conductor such as ebonite. The commutator is shown in

the figure, *a* and *b* are complete brass rings, c and c¹ are half rings, *x x* are the brushes pressing on the rings, the course of the currents is shown by the arrows.

178. "Signalling upon railways by means of electricity." C. E. Spagnoletti. Dated January 12. 6d. Has for its object improvements in railway signals and signalling, and is also particularly suitable for working junctions and large station yards, where main lines are intersected by crossings, and shunting operations are frequent or continuous.

231. "Telephonic conductors." C. W. Siemens. (A communication from abroad by Frank Jacob, at present on board the steamship *Faraday*, on the high seas.) Dated January 17. 6d. As telephone instruments are usually arranged, a complete circuit is formed including in each case a battery, a sending instrument and a receiving instrument, these two instruments being connected by two insulated wires for the forward and backward electrical currents respectively. The two wires are often twined together in one cord, this having the effect of preventing interference by induction from adjacent wires. When a number of sets of telephonic instruments are employed it is necessary, as they are at present arranged, to provide in the manner described a complete circuit for each receiver, that circuit requiring the two wires as stated above. Now the object of this invention is to render a number of such pairs of wires capable of supplying an increased number of instruments, by arrangements such that one receiver can be worked for each wire instead of one receiver for each pair of wires, as at present. In order to illustrate the invention, let it be supposed that there are two adjacent circuits, A and B, as at present arranged, each circuit having its battery, its sender, its receiver, and its pair of wires, making in all four wires. Now the inventor forms an additional circuit, C, with its battery, sender, and receiver, using the pair of wires of the A circuit for the forward current and the pair of wires of the B circuit for the backward current. There is also formed a fourth circuit, with its battery, sender, and receiver, using the four wires of the C circuit for the forward current and earth for the backward current. In this manner four sets of instruments can be worked by the use of four wires. As another illustration let it be assumed as before that there are the two complete circuits, A and B, and that there are two other similar adjacent circuits, *a* and *b*. There is formed as above described a third circuit, C, by using the pair of wires of A for forward and the pair of wires of B for backward currents, and in a similar manner there is formed another circuit, *c*, by like use of the wires of *a* and *b*, or that there are six circuits with eight wires. But a seventh circuit, D, can be formed by using the four wires of C and the four wires of *c*, and an eighth circuit, E, by using the eight wires of D and earth for return. And thus eight circuits can be effected by the use of eight wires.

In carrying out this invention as above described, any known kind of conductors may be employed, and along with them suitable resistances, condensers, or other known arrangements for determining the various circuits. Fig. 1 of the accompanying drawings illustrates a simple combination in which the two wires, L, connecting two instruments, A and A¹, are utilised as a single line with extensions, *l l*¹, of any required length for connecting two other instru-

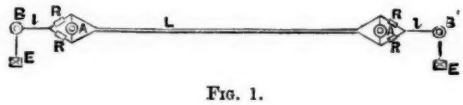


Fig. 1.

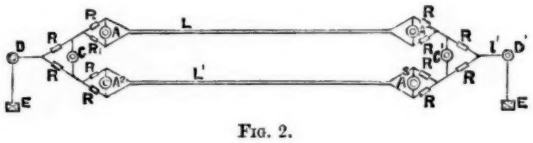


Fig. 2.

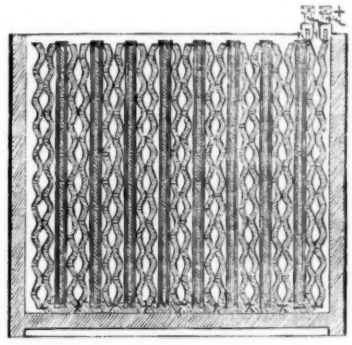
ments, B and B¹, earth, E, being used for the return part of the circuit of the latter pair of instruments. The first instruments, A A¹, are conveniently situated within a bridge, in the limbs of which resistances, R, are introduced, these resistances being arranged so as to equalise the potentials on the two sides of each instrument. Fig. 2 illustrates a combination for working four pairs of instruments with four wires, employing earth for the return part of the circuit of the last pair. In this case the two pairs, A A¹ and A² A³, are connected by their double wires, L L¹, respectively. These two pairs of wires, L D¹, complete a circuit for a third pair of instruments, C C¹, and the four wires of L L¹, with earth for return, complete a circuit for a fourth pair of instruments, D D¹. The instruments, A A¹, A² A³ C C¹, are situated in bridges, with resistances, R, arranged in the limbs of the bridges. As stated above, it is usual to protect telephonic conductors against interference by induction by twining together the pairs of wires forming their respective circuits. When two such pairs are combined to operate for another circuit it is of advantage also to twine together the two strands, each consisting of a twined pair, thus producing a strand which in its turn may be twined with a similar strand when four pairs are combined, and so on according to the number of pairs of wires entering into the combination.

232. "Permanent way for electric and telephonic conductors." H. R. Meyer. Dated January 17. 6d. Relates to an improved permanent way for electric and telephonic conductors, such as wires, or ribbons used for telegraphic electric lighting, telephonic, electric power, and various other like purposes. According to the invention the inventor constructs an underground or subterranean permanent way for electric and telephonic purposes in the following manner. The inventor uses blocks, or slabs, or channels of any suitable non-conducting material such as glass, earthenware, porcelain, terra cotta, cement, or asphalte. The blocks, slabs, or channels are formed of any convenient section, and are tongued and grooved and otherwise attached together end to end. The upper surface of the block, slab, or channel formed with ridges projecting up on each side, and there are also provided such upper surfaces with grooves running longitudinally and the wires, ribbons, or their equivalent, are placed in these grooves. The wires, ribbons, or their equivalent, and all the joints of the permanent way are then covered with a suitable non-conducting material such as asphalte, tar, pitch, resinous gums, cement, paraffin, or stearines. The blocks, slabs, or channels are covered with slabs, flags, or slates of the same material as the blocks, or other suitable material. These covers are pitched to lap the joints of the underneath blocks, and are arranged to lap over each other and over the sides of the blocks, slabs, or channels.

234. "Dynamo-electric machines." W. R. Lake. (A communication from abroad by C. A. Hussey and Amzi Smith Dodd, both of the City and State of New York.) Dated January 17. 6d. Relates to dynamo-electric machines. It is known that in these machines as ordinarily constructed, only those coils of wire which are passing between the poles or consequent points of the field-magnets are effective in producing currents of electricity, and that the other coils of the armature are for the time rather detrimental than otherwise because they offer a resistance to the passage of the current of electricity produced. One object of the present improvements is to effectually obviate this defect and to this end the said improvements consist in the combination in a dynamo-electric machine, of a field magnet and an armature severally having cores composed of arc-shaped portions wound with wire, intervening arc-shaped portions, and radial portions connecting the two series of arc-shaped portions; the radial portions of both the field-magnet and armature forming poles, polar extensions, or consequent points, and extending towards each other. The field-magnet core will preferably be made of one integral piece of metal and the armature-core of many thin pieces of metal.

245. "Apparatus for regulating electric currents." W. R. Lake. (A communication from abroad by Achille de Khotinsky, of Paris.) Dated January 17. 6d. This invention has for its object to provide an automatic current regulator which is based on the following principles:—First. To establish, by means of a conductor with variable resistance, a derivation in the circuit of the current operating upon the bobbin of a dynamo-electric machine (either an exciting or a generating machine) before its entrance into the coils of the inducing electro-magnets, and so provide means for varying the electromotive force of the principal current. Secondly. To establish a derivation with variable resistance in the circuit of the current operating upon the bobbin before its entrance into the coils of the electro-magnets, and at the same time to place in the circuit of the current which excites the electro-magnets of the inductor another resistance whereby variations in the intensity of the principal current can be obtained.

252. "Electrical accumulators." H. H. Lake. (A communication from abroad by La Société Universelle d'Electricité Tommasi, of Paris.) Dated January 18. 6d. Relates to secondary batteries or accumulators, its chief object being to improve the working and increase the power of such batteries by means of a considerable augmentation of the surface of the elements combined with a light weight and small volume. In carrying the said invention into practice each



element of the accumulator is formed of two continuous sheets of lead bent or folded several times and placed in a vessel of gutta-percha or other suitable material in such a manner that a double bend or fold of the one is always contained in a double bend or fold of the other; the sheets being thus placed in juxtaposition at a certain distance from and parallel to each other. The plates are also perforated with holes to allow of the circulation of the liquid. The arrangement is shown by the figure.

278. "Effecting electro-hydo-therapeutic treatment of patients affected by disease." W. A. Barlow. (A communication from abroad by Messieurs L. Encausse et Canésie, of Paris.) Dated January 19. 6d. The apparatus is disposed in a chamber so that the whole treatment by both the cutaneous absorption and by electricity is effected in a regulated and simultaneous or successive manner. And this will be done without exposing the patient to any change in the temperature, which change is always injurious.

289. "Secondary batteries for storage of electricity." J. Humphrys. Dated January 20. 4d. Relates to improvements in the con-

struction of secondary batteries for storing electricity. It consists in making the plates of which the scondary battery is composed of an open lattice form, that is to say, the sides of the framework of each plate are connected with bars, either of a diamond or oval section, these bars being arranged at an angle on the principle of a "Venetian" blind, thereby exposing a maximum area or surface of spongy lead to the action of the liquid used in the battery.

290. "Telephonic conductors." H. J. HADDAN. (A communication from abroad by J. D. Morel, of France.) Dated January 20. 2d. Has for its object to record the conversation carried on through a telephonic conductor by combining with the same a phonograph. (*Provisional only.*)

302. "Voltaic batteries." A. R. BENNETT. Dated January 21. 4d. Has for its object the production of a cheap and effective single-fluid voltaic battery. To form the negative portion of the battery the inventor places an electrode of iron or steel packed tightly in small fragments of the same metal, such as iron or steel turnings or borings, or clippings of iron or steel wire, in a solution of potassium monoxide, potassium hydroxide, sodium monoxide or sodium hydroxide. To form the positive portion of the battery, which should be separated from the negative by a porous cell or diaphragm, the same solution is used immersing in it an electrode of zinc, the shape of which is immaterial.

316. "Telephone transmitters." E. G. BREWER. (A communication from abroad by Joseph Olmsted, of New York.) Dated January 21. 6d. Relates to telephone transmitters in which the current from a galvanic battery passing through contact electrodes or points is varied by the impingement of the air waves or vibrations accompanying vocal sounds upon some portion of the instrument to which the electrodes are connected. The invention herein described as applied in connection with transmitters employing a disc or diaphragm, but the novel electrode or contact-piece herein described is applicable to other constructions of telephones, or may be used as a variable contact in a microphone. In telephone transmitters it has heretofore been common to employ but one electrode for making contact with the electrode which receives motion from the diaphragm, and in those cases where a number of electrodes have been employed making contact abreast or in multiple arc with a number of opposite electrodes or a single electrode common to them all, springs have been employed for holding the electrodes in contact and independent adjusting devices have been employed for the various electrodes. This invention consists, first, in a novel construction of telephone in which is employed a series of independently pivoted electrodes forming together a compound electrode, and resting against an opposite electrode by their own gravity, and mounted upon a common adjustable support whereby the same, or practically the same, initial contact is secured for all, and all may be adjusted together for varying the contact. In former arrangements employing separate adjusting devices, it is impossible to determine the adjustment that will give the same contact for all, whereas in this arrangement, each electrode being actuated only by an invariable force like gravity, and all having a common adjustable support, the adjustment of the instrument can be accomplished with the certainity that the contact of all the electrodes has been varied to the same extent for all. This invention consists, secondly, in a novel contact or electrode composed of a thin sheet of carbonised paper or cardboard, or of a number of such sheets arranged side by side to make a compound electrode, said sheet or sheets being mounted so as to rest with its edge against the opposite electrode. A compound electrode thus constructed is very constant in its action, and transmits sounds with great volume and accuracy. Instead of carbonised paper a thin sheet of metal, like platinum or german silver, is sometimes used resting in the same manner with its edge against the opposite electrode. In the accompanying drawings fig. 1 is a partial vertical section of a transmitter embodying the invention. Fig. 2 is a rear view of the operative parts of the instrument, the back being removed. A represents the casing of the transmitter, B its mouth-piece, and C the metallic disc or diaphragm which is clamped between a ring, D, and a block, E, in any suitable manner, and is provided at its edge with a rubber dampening ring after a manner common in instruments of this class. F is an electrode which is attached to and moved with the diaphragm. This electrode consists of a longitudinal bar, having a bevelled edge and provided at or near its centre with a laterally projecting stud into which passes a screw by which said electrode is secured to the diaphragm. The edge of the bar, F, which forms the contact edge, is, by preference, of platinum. G G represent thin sheets of carbonised cardboard or paper strung upon a rod, H, of some conducting material and contained between two blocks, I I, also attached to the rod. The plates, G G, rest with their edges in contact with the edge of the bar electrode, F. The rod, H, is mounted in brackets, K K, which are of hard rubber or similar non-conducting material, and are suspended or attached to rods, L L, mounted upon the clamping ring, D, or any suitable portion of the instrument. The non-conducting brackets may be adjusted horizontally upon the rods, L L, thus carrying with them the supported bar, H, and the electrodes, G, and adjusting the degree of initial contact between the electrodes of the instrument. Upon the end of the conducting-rod, H, is a binding screw, N, which serves for the attachment of one portion of the circuit wire coming from the galvanic battery. Electrical connection is made with the electrode, F, by means of binding-screw, O, which is mounted directly upon the clamping iron, D, of metal, the latter being electrically connected with the diaphragm by means of a screw, P, which passes through the ring, D, and against or into the edge of the diaphragm. M M are set screws which serve to hold the brackets, K, at any desired position upon the rods, L. R represents the induction coil of the transmitter, the primary coil of which makes a portion of a local circuit, including the electrodes, G, F, and a galvanic battery, while its secondary coil is connected to line in the well-known manner. The various parts are electrically connected in the ordinary way well understood in the art, and the instrument operates after the manner of any contact telephone or microphone. The transmission of sounds is, however, accomplished with great distinctness and volume of tone, and the instrument will operate for an indefinite period without adjustment. The carbonised sheets, G G, may be of any desired number, and may be supported after any suitable plan. They are made by carbonising thin sheets of paper, cardboard, or other suitable material after the manner employed in forming the carbon strips of incandescent electric lamps, or in any other suitable manner.

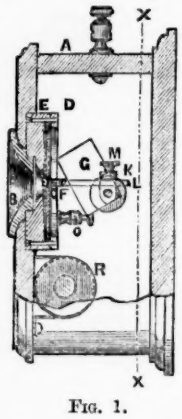


FIG. 1.

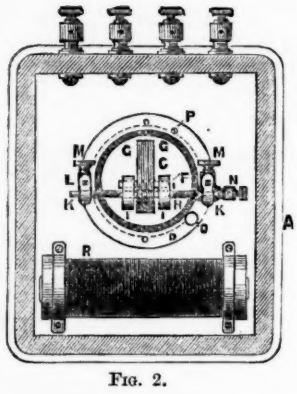


FIG. 2.

392. "Obtaining light by electricity, &c." W. P. THOMPSON. (A communication from abroad by the Union Electric Manufacturing Company, of New York.) Dated January 26. 6d. Relates to the electric regulator, described in the number of this Journal for July 29th, page 66.

2416. "Electric batteries." H. H. LAKE. (A communication from abroad by J. B. Wallace, of America.) Dated May 22. 6d. The object of the said invention is to construct a battery in which the largest carbon surface may be provided in the smallest space, and in the nearest or most uniform relation to the zinc; and the said invention comprises a glass or equivalent non-conducting covering plate for the battery jar, having a central opening to receive the zinc, and a series of openings around the central opening, combined with a metallic plate resting on the top of the glass cover and having openings corresponding with the openings which surround the central opening, each of the said openings being constructed to receive and hold a "carbon" (that is to say, a rod or piece of carbon) introduced through the openings in the glass cover, and so as to make an electrical connection between all of the carbons, and a connection for one wire with the central zinc independently of the carbon connecting plate, and the said carbon connecting plate being fitted for connection with the other wire.

DISCLAIMER.

The Edison Electric Light Company (Limited). "Systems of conductors for the distribution of electricity, &c." No. 3880. 1880.

CITY NOTES.

OLD BROAD STREET.

THE NATIONAL TELEPHONE COMPANY (LIMITED).

THE report of the directors for the year ending 30th June, 1882, states that a reference to the capital account will show the amount expended to 30th June. The directors beg to remind the shareholders that this company took over the businesses of several others, especially in Glasgow, Edinburgh, and Belfast, and has had to amalgamate their various systems. The outlay caused by this amalgamation has been considerable, but it has enabled the company to make important reductions in the staff and expenses. The various exchanges are now in good working order and the service offered to the public in all respects satisfactory. The gross revenue of the company at the 30th of June, 1881, was at the rate of £15,050 19s. 9d. per annum; at the end of the month of June this year, £26,996 3s. 10d., being an increase of 80 per cent. The net profits, after allowing for interest at the rate of 5 per cent. upon calls paid in advance, are £4,217 13s. 2d., which will enable the company to pay the preference shareholders 6 per cent. and to carry over £144 9s. 8d. The amount of rentals and subscriptions credited to the year was £19,243 10s. 11d., and the amount carried forward as gross revenue available for the current year £15,643 5s. 5d. The revenue is steadily increasing, at a higher ratio than the expenditure, and the directors anticipate a much larger profit during the current year. The company have twenty-six exchange licences from the Postmaster-General. The stations for which these licences are held are divided into those completed and contributing to the profits of the company, and those in course of construction, and drawing for their support from capital. There are now nine stations of the former kind, and it is the anticipation of the board that most of the new stations will be added to the self-sustaining list during the current year. The private wire business of the company is also steadily increasing.

Your directors are happy to be able to report that the United Company's defence of its patents in the courts of England and Scotland has been decisive and successful, making good its claim to the possession of the master patents for both transmitter and receiver. They have also pleasure in reporting to the shareholders that the Post-office officials throughout the company's districts act with consideration and courtesy in all their relations with its staff, and that so far as is consistent with the lines laid down by the Postmaster-General, the Department manifests a disposition to avoid placing unnecessary difficulties in the way of the operations of the company. The Postmaster-General has decided to grant exchange licences to responsible parties complying with certain specified conditions. Your directors do not apprehend that this decision will embarrass the transactions of the company, or tell against its prosperity. So long as the United Company's patents are maintained, and equally useful inventions not infringing them remain undiscovered, the decision of the Postmaster-General will not expose the company to legal or serious competition. Practically the company remains in the same position as regards exchange rivalry as if the Postmaster-General had not succeeded in establishing his right of monopoly in the public telegraph system.

On Friday the 18th instant the second annual ordinary general meeting of the shareholders of the above-named company was held at 11, Queen Victoria Street, under the presidency of Col. R. Raynsford Jackson, chairman of the company.

The secretary, Mr. W. B. Campbell, having read the notice convening the meeting,

The Chairman said: Gentlemen, you have all received the directors' report; do you wish to hear it read, or will you take it as read?

The report having been taken as read, the Chairman continued: Gentlemen, I have to move that the report of the directors be accepted and confirmed by the shareholders. It is not my intention to dwell at any great length upon the position and prospects of the company. They are sufficiently, I think, indicated in the balance-sheet and in the report. You will see that the company's income for last year—or rather its revenue at the end of the last year—had reached within a small fraction of £27,000; then the profits for the year were £4,217 15s. 2d., which has enabled the directors to declare a dividend upon the preference shares of 6 per cent. and to carry forward a balance of £144 9s. 8d. One feature in the position of the company, which I think will be regarded as favourable, is that we carry forward £15,643 5s. 5d. towards the gross revenue of the current year. The company's business is divided into two kinds. There is the private wire business, which is entirely independent of the control of the Post-office, for which we do not require the Postmaster-General's licence. That business is on the increase, and I have no doubt that in the course of the current year and in future years it will receive a very large development. For the exchange business we require the Postmaster-General's licence, and it has been the policy of the Postmaster-General up to recently not to grant licences to more than one company in one town. I do not mean to say that there has been no exception to that rule, because in Dundee two existing telephone companies were granted licences. But the Postmaster-General has resolved to alter that rule that there should not be rival telephone companies in one town, and to allow responsible parties applying for licences to the Department to enter into rivalry for the telephone business, for the exchange and branch of the telephone business. This company is under no apprehension whatever as to the consequences of the competition which may arise from the decision which I have just mentioned of the Postmaster-General. In the first place, the company's business is based to a certain extent upon the exclusive license it holds from the United Telephone Company to use its telephones, to act under its patents, and as the United Telephone Company has with great spirit defended its practical and legal possession of the master patents which control the telephone business, the Postmaster-General's licence will not be of any great value to any rivalry. Unless a company enters into the exchange business with full possession of telephones it is practically out of the field. Therefore we do not fear competition. There is another and stronger reason why I do not think we have much to fear from competition of that character, that is that we have the Postmaster-General's licence to establish exchanges in many of the most important towns in the United Kingdom. We have already established exchanges that are giving a good and satisfactory and cheap service, and therefore we do not think that any competitor would have very much chance of successfully taking us in in any way in those places where we have established. The Postmaster-General, in a speech which he made in the House of Commons last Saturday has, whilst indicating his change of policy, made some remarks which, I think, are deserving of attention of all who are interested in the telephonic enterprise. He says that if the private telephone companies do the telephone business better than the Post-office, the Department would be delighted to have all the telephone business of the country conducted by private companies. He says later, if on the other hand it was proved that the business was done better by the Government than by the companies, the Government would have beaten the companies in the open field of competition, and occupy the ground without any question of purchase arising. Now the Postmaster-General is a man of logical mind, who weighs most minutely all his utterances before he puts them into speech before the House of Commons; and I think we may fairly conclude that he has thoroughly made up his mind before making this speech, and we may regard it as indicating truly his purpose. If therefore, he is prepared to welcome the development of the private telephone business, if he will be quite satisfied should the telephone companies beat the Post-office in fair competition, if he is prepared that the competition shall be a fair one, then I think that we have very little to apprehend from the competition of the Post-office; and I am quite convinced that so long as the present Postmaster-General is in office we shall only be opposed by fair competition from the Department. The Department has some advantages over a private company. It is in the position of having a very experienced staff. It has the advantage of being able to rest upon Acts of Parliament. It has also behind it the national purse. On the other hand the private companies have advantages of another kind, upon which they may rely with confidence. They have more elasticity of action; they are better able to secure large and generous support in the various localities; they have representatives of influence and importance in every district where they do business on their board of directors; and they are assisted by local boards and influential gentlemen in the towns where they do business, aiding to carry forward the business of the company. I think the National Telephone Company, constituted as it is and relying as it does on the absolute fairness of the Post-office department—I think that, bearing all these things in mind, the National Telephone Company may rest perfectly satisfied upon the basis upon which its business rests. I have to point out to the shareholders that there has been a loss during the current year in the trunk business of the company, and it may be necessary that I should explain what the character of that business is. When the Postmaster-General agreed to grant exchange licences to the various companies, he determined to keep the trunk business, that is the telephonic business between town and town, because he apprehended that if he did not the Post-ffice would lose very considerably in its postal telegraph revenue. After representations made to him he agreed that the Post-office should itself erect communications between our central exchanges in different towns. For example, the Postmaster-General has given us communication between Leeds and Bradford by a wire erected by the Post-office, but the terms upon which that privilege was granted us was upon terms that we should pay the Postmaster-General for eight subscribers, whether we obtained eight or not, and we have, in order to develop the telephonic enterprise in our various districts, run the risk of paying the Postmaster-General for a trunk wire, without having in the first instance secured eight subscribers. In some places we have only three subscribers where we have paid for eight. You will say, perhaps, that it was unwise for the company to have agreed with the Postmaster-General for the erection of these wires without having first secured the number of subscribers required by the Postmaster-General. It was, however, thought that it was necessary in the public interest and for the sake of developing the telephonic enterprise to run some risk, and in Yorkshire we ran the risk of coupling up the various towns in which we are interested, and agreeing to pay the Postmaster-General for nine different trunk wires. One effect of the course we have pursued is that the *Leeds Mercury* has become a subscriber to every one of our wires and to every one of our exchanges, and it is thus enabled to hold communication with its agents in Yorkshire a minute or two before going to press. Now, had we not run some risk of incurring some loss in adopting the trunk system the *Leeds Mercury* would not have been able to do that, and the force of its example on the telephonic enterprise would have been lost. I have an idea that there will be before long a change in the decision of the Department with regard to the trunk system. The inclination of the Postmaster-General and of the Post-office is to feel its way, and as it discovers that the alteration is beneficial to the public and the companies, without being detrimental to the interests of the Department, it is disposed to make changes which seem to be indicated as wise by the circumstances. I have great confidence that before we next meet the shareholders at an annual meeting I shall be able to announce that the trunk system is on a better footing. I am sure we should be, if we were as free with the trunk system as with the exchange. I have thought it necessary to enter into these explanations for two reasons, one that the shareholders may understand our position in this important matter, and that our subscribers may understand that we are giving them this service at a loss to the company. There is nothing further of moment that it is necessary to bring before the shareholders. I think they will be satisfied with the progress that the company has made, and I feel confident we shall be able to put before you another year a better and more favourable report, showing a larger balance on the year, and I have great confidence in the success of our enterprise. I may, however, return to the Post-office in order to refer to a matter of the Postmaster-General's, which, I think, it is well that I should make reference to. The Postmaster-General is apprehensive lest the idea that the Government intends taking over the telephone companies should lead to speculation in the shares, and thus undoubtedly enhance their value. I must say that, for this company, I learn with great satisfaction that the Postmaster-General has no idea of purchasing the telephone companies. When the Postmaster-General granted to us the exchange licences, he reserved to himself the right to take over the companies at certain periods upon valuations based upon certain principles. I think he proposed to take over the exchanges in 1890. If I could put him off till 1990 I should be glad (laughter). Therefore I learn that it is not the intention of the Postmaster-General to buy up the telephone companies. We ask only to be left free to enter into competition with the Post-office and other telephone companies, and we shall then have the fruit of our enterprise without the risk of having it taken over by the Government. I beg to move the adoption of the directors' report by the shareholders.

Mr. W. A. Smith said he rose to second the adoption of the report, but after the Chairman's very exhaustive statement, he did not think there was very much left for him to say. He could only heartily endorse all that he had said. He should like to point out to them one of the best features in the report. It was called the second annual meeting, but it really was the first, for their first annual meeting was almost a statutory meeting, as it was held very shortly after the formation of the company. In the brief space of one year, then, they had more than doubled their revenue. He did not require to point out to them the good point that was in the balance-sheet, because there were many charges fixed, or practically fixed. If their revenue went on in future years as it had done in the past the result could not fail to be highly satisfactory to the shareholders.

The proposition was then put by the Chairman and carried unanimously.

The re-election of the following retiring members of the board, Messrs. Jeremiah Garnett, John Bruce, and W. A. Smith was proposed by the Chairman, and having been duly seconded they were accordingly declared members of the board.

The Chairman also proposed the re-election of the auditors of the company, Messrs. Quilter, Ball & Co., which, having been seconded by Mr. W. A. Smith, was declared carried.

Mr. F. F. Begg (Edinburgh), in proposing a vote of thanks to the chairman and directors, said they had listened with pleasure to his exposition of the position of the company. He thought Colonel Jackson had shown them very clearly that he had a thorough grasp of the whole subject, and did not neglect any opportunity of advancing the interest of the company. But there was one matter upon which he did not enter, and to which he should like to refer. They might suppose that in making up a report the figures were made up from theoretrical knowledge, but he knew of his own knowledge that Colonel Jackson had made repeated visits to all the centres of the company during the year. He had gone as far north, he believed, as Aberdeen, certainly to Dundee. In fact, he had done the work of a general manager. He would be the last, he knew, to take all the credit to himself, for he was surrounded by a board of directors who seconded his efforts to the best of their power. He would, therefore, move that the thanks of the meeting be given to the chairman and directors.

Mr. C. J. Bell seconded.

The Chairman briefly returned thanks for himself and his colleagues. The board, he said, were representative men in their respective districts; they were men of energy and business, and had been selected for their local influence and business capacity.

The proceedings then terminated.

THE SOUTH EASTERN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

ON Thursday afternoon an extraordinary general meeting of the members of this company was held at the Cannon Street Hotel, under the presidency of Sir Michael Kennedy, for the purpose, if thought proper, of confirming the following special resolutions modifying the Articles of Association, passed at the extraordinary general meeting of the company held on the 9th inst., viz.:—"That the Articles of Association of the company be, and the same hereby are, altered as follows:—(1) By the insertion of the following words at the end of Article 4: 'Provided always that no share shall be issued at a discount without the sanction of a general meeting;' (2) by the alteration in Articles 81 and 89 of '1886,' therein mentioned, to '1884.' (3) By the omission of Articles 85 and 100."

There being just a quorum of shareholders present,

The Secretary, Mr. Alfred Jermyn, having read the notice convening the meeting,

The Chairman said: Gentlemen, we have met here only for the formal purpose of confirming the resolution which we passed at our last special meeting. There is no other business to be done at this meeting, and I need not address you at any length upon this matter. I merely propose the resolution which has been read to you, and I suppose you will take it as read?

Mr. Fry (a Director): I will second that.

The Chairman then put the resolution to the meeting, and it was carried unanimously.

PROVINCIAL (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

SIR MICHAEL KENNEDY presided on Thursday over an extraordinary general meeting of the members of this company, held at Cannon Street Hotel, for the purpose, if thought proper, of confirming the following special resolutions, modifying the Articles of Association, passed at the extraordinary general meeting of the company held on the 9th inst., viz.:—"That the Articles of Association of the company be, and the same are hereby, altered as follows:—(1) By the insertion of the following words at the end of Article 4:—'Provided always that no share shall be issued at a discount without the sanction of a general meeting.' (2) By the alteration in Articles 81 and 89 of '1886,' therein mentioned, to '1884.' (3) By the omission of Articles 85 and 100."

The notice convening the meeting having been read by the Secretary, Mr. Alfred Jermyn,

The Chairman said: Gentlemen, our meeting is very special, and I think will be very brief. It is merely called that I should move the resolution which you have heard read by the secretary, which is confirmatory of the resolution passed on the occasion of the last meeting. I beg to move the resolution which has been read to you by the secretary.

Mr. Fry (a Director): And I beg to second it.

The resolution having been put to the meeting was carried unanimously, and the proceedings terminated.

BRUSH MIDLAND ELECTRIC LIGHT AND POWER COMPANY, LIMITED.—The directors have elected Mr. R. H. Glyn as chairman.

LONDON AND GLOBE TELEPHONE AND MAINTENANCE COMPANY.—The letters of allotment of this company have been posted.

WESTERN UNION TELEGRAPH COMPANY.—Messrs. Morton, Rose and Company notify the payment on September 1 of the interest due on the bonds of this company's Six per Cent. Sterling Loan.

BIRMINGHAM MUSICAL FESTIVAL.—There is to be a somewhat extensive installation of Electric Light at this festival, the work being undertaken by Mr. Crompton, in conjunction with Messrs. Winfield & Co. Twelve Bürgin machines are to be used, driven by a 120 horse-power engine; these to be stationed about 200 to 300 yards away from the hall.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotations. Aug. 23.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	4	11¼-12½	12 7/16-12 5/8 11 15/16-12 1/16 11 7/8-12	12 5/16-12 7/16 11 7/8 xd.
		Do. Do.	10	25 - 30	26 7/8
30,000	5	Australasian Electric Light, Power & Storage Co.	3	⅜ - 1½	1¼
24,900	10	British Insulite Co., Limited, "A" Shares	5	4½ - 5	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	1½ - 1⅝	
25,000	5	Great Western Electric Light & Power Co.	2½	1 - 1½	1¼ 1
24,980	5	Hammond Electric Light & Power Supply Co.	2½	6½ - 7½	7 1/16-7 1/8-6 15/16-7 1/8-6 15/16-7 1/16-7 1/8
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	1½ - 2	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	⅜ - ½	
40,000	5	Pilsen, Joel & General Electric Light Co	2	1½ - 2	
100,000	5	Swan United Electric Light Co., Limited	2	1½ - 1⅝	1½
		TELEGRAPHS.			
2,116,400£.	Stk.	Anglo-American, Limited	100	49½ - 50½	50 1/2 50
2,441,800£.	Stk.	Do. Preferred Def'd. receiving no div until 6 p. c. has been paid to Pref.	100	79½ - 80½	80 79 1/2
2,441,800£.	Stk.	Do. Deferred	100	19½ - 20½	20
130,000	10	Brazilian Submarine, Limited	10	11⅜ - 11⅝	
16,000	10	Cuba, Limited	10	9⅝ - 10	
6,000	10	Do. 10 per cent. Preference	10	16 - 17	
13,000	10	Direct Spanish, Limited	9	6 - 6½	
6,000	10	Do. 10 per cent. Preferences	10	15 - 16	
65,000	20	Direct United States Cable, Limited, 1877	20	11½ - 12	11½ xd
100,000£.	100	Do. 6 per cent. Debenture, repayable 1884	100	101 -104	
380,000	10	Eastern, Limited	10	10½ - 10⅝	10 9/16-11/16
70,000	10	Do. 6 per cent. Preference	10	12½ - 13	
232,000£.	100	Do. 6 do. Debentures, repayable Oct. 1853	100	99 -102	
200,000£.	100	Do. 5 do. do. Aug. 1887	100	100 -103	
200,000£.	100	Do. 5 do. do. Aug. 1899	100	100 -105	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11¼ - 11⅜	11 3/8
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	104 -107	107
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1909	100	102 -105	
140,000	100	Do. do. registered, repayable 1909	100	102 -105	
100,000£.	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300£.	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan. 1900	100	100 -103	
345,700£.	100	Do. do. do. To Bearer	100	100 -103	
22,050	10	German Union Telegraph and Trust, Limited	10	9½ - 10½	10
163,330	10	Globe Telegraph and Trust, Limited	10	6¼ - 6⅝	
163,200	10	Do. 6 per cent. Preference	10	12½ - 13	
125,000	10	Great Northern	10	12½ - 12⅝	
100,000£.	100	Do. 5 per cent. Debentures	100	100 -103	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	26½ - 27½	27
100,000	100	Do. 6 per cent. Debentures, 1886	100	101 -105	
17,000	25	Indo-European, Limited	25	29 - 30	
38,148	10	London Platino-Brazilian, Limited	10	4½ - 5	
12,000	10	Mediterranean Extension, Limited	10	2 - 2½	2¼
8,200	10	Do. 8 per cent. Preference	10	8½ - 9	
9,000	8	Reuter's, Limited	8	12⅝ - 13½	
230,000	Stk.	Submarine	100	255 -265	xd.
58,225	1	Do. Scrip	1	2⅜ - 2⅝	
4,200	Cert.	Submarine Cables Trust	100	98 -103	
37,350	12	Telegraph Construction and Maintenance	12	27½ - 28½	
150,000	100	Do. 6 per cent. Bonds, 1884	100	102 -104	
186,750	5	Do. 2nd Bonus Trust Cert.	5	1⅜ - 1½	1 9/16
30,000	10	West Coast of America, Limited	10	4⅞ - 5⅛	
150,000	100	Do. 8 per cent. Debentures	..	..	
69,910	20	Western and Brazilian, Limited	20	6⅞ - 7⅛	6⅞
200,000£.	100	Do. 6 per cent. Debentures "A" 1910	100	104 -107	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	97 -100	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	123 -128	
1,030,000£.	100	Do. 6 per cent. Sterling Bonds	100	103 -106	
88,321	10	West India and Panama, Limited	10	1⅞ - 2	1 15/16
34,563	10	Do. 6 per cent. 1st Preference	10	8½ - 9	8⅝
4,669	10	Do. 6 do. 2nd do.	10	6¾ - 7⅛	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	1⅛ - 1⅜	1 1/16
200,000	1	Oriental Telephone Co., Nos. 100,000 to 300,000	½	⅜ - ½	½
100,000	5	United Telephone Co.	5	9½ - 9¾	9 7/8-9 3/4-9 7/8-9 3/4 xd.

TRAFFIC RECEIPTS.

The Eastern Telegraph Company. The traffic receipts for July were £51,600, against £38,171 in the same month of 1881.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the five weeks ending 21st and 28th July and 4th, 11th and 18th August, 1882, were £1,623, £1,882, and £1,661, £1,718, £1,752, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

West India and Panama Telegraph Company (Limited). The estimated traffic receipts for the half-month ended the 15th August are £2,382, as compared with £1,704 in the corresponding period of 1881. The May receipts, estimated at £6,542, realised £6,501.